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THESIS

FORMATIVE EVALUATION OF THE TACTICAL PATROL CRAFT TRAINER: A COMPUTER-BASED TRAINING EVALUATION

by

Dean Jacobs

June 1997

Thesis Co-Advisors: Gail Fann Thomas
Alice Crawford

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FORMATIVE EVALUATION OF THE TACTICAL PATROL CRAFT TRAINER: A COMPUTER-BASED TRAINING EVALUATION

Dean A. Jacobs
Lieutenant, United States Navy
B.S., University of Utah, 1991

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ABSTRACT

This thesis describes the formative evaluation of the Tactical Patrol Craft Trainer (TPCT) during the implementation stage. The TPCT is an interactive multi-media computer-based trainer designed to deliver a full fidelity and analog video training scenario to Prospective Commanding Officers (PCOs) of the Coastal Patrol Craft (PC) class ship. The system is designed to induce stress while enhancing autonomous decision making skills. The methodology involved six survey instruments, observation, and interviews with the trainees. The data show that the TPCT induces stress as intended, the user interface is appropriate, and the trainees perceived the training as valuable. Several improvements are noted in the course structure, user-interface, and system application. Recommendations are made for more scenarios, additional applications of the technology, and evaluation of training effectiveness after the final implementation of the system.

TABLE OF CONTENTS

I. INTRODUCTION

A. BACKGROUND

1. Simulation and Instructional Technology

From the beginning of this century simulators have been a necessary tool for safer and more efficient flight training. The trainers in use during this period were mechanical mock-ups that simulated aircraft control. With advances in computer technology came advances in instructional technology. The U.S. Navy was experimenting with and studying instructional media and simulation as early as 1941 (Ellis, 1986). Distance learning, video teleconferencing, computer-based simulations, CD ROM courses, and the Internet are all advances in instructional technologies. Most of the technological advances are computer based including the use of multimedia computer video formats that integrate traditional video with computer power.

We can do things with technology that are not possible without it. For instance, we can simulate flight for the novice; we can show how truly volatile a chemical is without exposing the student to risk; and we can put the trainee in simulated combat situations that were not possible before. Advances in instructional technology have provided us with a means to enhance the training environment without putting the trainee in danger or resulting in the loss of valuable equipment. The development of "safe, novel training techniques, which could be achieved through simulation and mass training media" was the charter behind the establishment of the Navy's Special Devices Center in 1941 (Dreves, 1971). Studies as early as the 1940s proved that simulators could effectively reduce actual flight training time (Ellis, 1986). Flight training simulators led to developments in other simulators that provided

effective and safe training alternatives including nuclear reactor trainers and surface ship trainers.

2. Tactical Patrol Craft Trainer (TPCT) Background

The TPCT was developed to fill a void in the training pipeline of U.S. Navy Officers who would take command of a Coastal Patrol (PC) class ship. High stress autonomous decision making skills are not part of the normal training pipeline or experience level of these officers. The need was apparent for a system that would reinforce selected training points and enhance the decision making capability, under stress, of the prospective Commanding Officer (CO). Commander Naval Special Warfare Command[1] (COMNAVSPECWARCOM) needed a training system that would stress the student in a realistic environment, enhance advanced decision making skills, and emphasize training elements of concern to the Coastal Patrol Boat (PC) community.

The Integrated Damage Control Training Technology (IDCTT), an interactive multimedia system developed for training Damage Control Assistants (DCAs) on Naval Ships, provided "levels of reality and stress that have not been experienced in damage control training before" (Fuller, 1993). Developers decided that the IDCTT could be adapted to create a system capable of producing the desired training environment for PC Commanding Officers. The IDCTT is discussed in further detail in the literature review section of this thesis. From a statement of requirements for further training and the use of current technology, the TPCT was developed.

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[1]The PC class ship is directly under the control of COMNAVSPECWARCOM.

Systems Integration & Research, Inc. (SIR) was awarded the contract by COMNAVSPECWARCOM to assemble the full fidelity computer hardware components, develop and program[2] the initial TPCT scenario, produce the analog video segments for incorporation into the scenario, and program the interface for the Integrated Bridge System (IBS).[3] SIR was also tasked with installing the system, conducting initial system testing and evaluation, and implementing the system. This thesis was conducted with the support of COMNAVSPECWARCOM during the initial installation phase.

B. AREA OF RESEARCH

The purpose of this research is to evaluate the TPCT during its installation phase. This research is the beta testing of an interactive multimedia computer training system prior to general use. Beta testing is the pre-implementation evaluation of a computer system to determine if hardware or software improvements are needed prior to release to the customer. This formative evaluation analyzes the training system while test subjects use it before final implementation. This evaluation is an important part of computer system development. Goldstein (1993) indicates that it is essential for developers to determine, through formative evaluation, if improvements are needed before a training system is put in operation.

C. RESEARCH QUESTIONS

The primary research objective is to conduct formative evaluation of the trainer and make recommendations for implementation. Specific research questions are:

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[2] The programing was subcontracted to Tekamah, Inc.

[3] The IBS is a navigation and control system developed by Sperry Marine, Inc. that is in use on the PC class ship.

1. What system changes need to be achieved prior to implementation?

    a. What changes need to be made in the Instructor's Guide?

    b. What changes need to be made in the Student's Guide?

    c. What software problems need to be corrected?

    d. What hardware problems need to be corrected?

    e. What additional instruction needs to be conducted prior to using the trainer?

2. What initial indications of system effectiveness are produced during beta testing?

3. What variables need to be collected to create a database that will allow future analysis of training performance?

4. During initial beta testing, what variables are significant factors in the successful completion of the trainer?

D. SCOPE OF THESIS

The primary thrust of this thesis is a formative examination of the TPCT in beta testing and recommendations for implementation. The thesis identifies training system improvement needs, initial indications of system effectiveness, and initial factors of successful trainer completion. This study is not a comparative analysis nor does it address cost effectiveness. The TPCT is still in the installation phase and the analysis will be an integral element of the beta testing. The analysis does not measure the ultimate effectiveness of the TPCT.

E. ORGANIZATION OF THESIS

Following the introduction, this thesis is organized into five chapters. First the literature review discusses those areas pertinent to the thesis. Works are reviewed that detail beta testing, simulation (including the IDCTT), training and evaluation, and those works used to evaluate decision making. The next chapter is a detailed TPCT description. This chapter

familiarizes the reader with the basic TPCT concept, the physical components (system hardware), and the software (including basic scenario description). This chapter provides the reader with fundamentals to understanding the research that follows.

The research chapters begin by describing the methodology. The methodology that was planned in the research design phase is contrasted with the actual methodology used. The shift in methodology was an important factor in the collection of data. Next is a presentation of the data and analyses followed by conclusions and recommendations. The last section also includes current status of the recommendations[4].

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[4]Recommendations were submitted to COMNAVSPECWARCOM during the testing phase.

II. LITERATURE REVIEW

The literature reviewed pertaining to this research is divided into three sections. The first section looks at literature in the area of training evaluation. Second, beta testing and computer system evaluation literature is reviewed. Third, is a review of the literature on technology including simulation and its use in training. This section includes studies that look at the Tactical Patrol Craft Trainer (TPCT) predecessor, Integrated Damage Control Training Technology (IDCTT), and the literature on decision making and the effects of stress is reviewed.

A. TRAINING EVALUATION

Evaluation is an integral part of a training system. It is not a stand-alone element. It must begin at inception and continue through the life of the system to provide feedback for system improvement and effectiveness. Goldstein (1993) describes a systems approach to training that includes needs assessment, development and training, evaluation, and validation in a looped feedback system. This approach would seem to indicate that evaluation has one definitive and specific place in the training system. But, further exploration of each system component makes it apparent that each phase contains its own element of evaluation that feeds back into the system (Goldstein, 1993).

The evaluation phase in this model deals with the summative and formative evaluation of a training system. Summative evaluation primarily looks at expected outcomes of a completed system or whether the system is more effective than an alternative system. Summative evaluation also includes cost-benefit analysis. Formative evaluation tests review

a training system during its design and implementation to ensure that basic concepts work. The difference between summative and formative evaluation, and the importance of both as separate instruments, is important to the evaluation conducted. As noted by Goldstein, "[m]any research problems result from one-shot evaluation studies that attempt to combine formative and summative evaluations" (Goldstein, 1993). To have an effective system, summative evaluation must follow formative evaluation in the process of training system development (Goldstein, 1993). This thesis does not attempt summative evaluation and is concerned only with the formative evaluation in the implementation phase.

B. COMPUTER SYSTEM EVALUATION

Computer system evaluation can take on many forms and can occur at various points in the system's life cycle. In the beginning, hardware tests may include mechanical stress and electronic congruity testing. The software may undergo programmer logic checks that determine if the code operates as expected. Toward this end, there are software tools designed to test a computer system. For example, Rose (1996) prepared an extensive article about the use of automated testing tools in the quality assurance of computer systems. Her assertion is that the use of automated test tools is a necessary element in the testing cycle to reduce the time-intensive process of manual testing. But in the article she also emphasizes that the formative evaluation, what she calls beta testing, involving the end user, can not be completely replaced with automated testing. In fact, she indicates that the formative evaluation of the user interface is essential to the successful performance of the system.

A procedure for evaluating the user interface performance of computer-based multimedia systems for training is described by Reeves and Harmon (1994). The procedure,

"User Interface Dimensions," is based on elements that evaluate usability of the system. They present a thesis in which the value of a computer-based training system can be evaluated based on whether "users have a meaningful and purposeful experience" while using the system. The procedure evaluates user responses in areas "such as ease of use, media integration, and cognitive load" (Reeves & Harmon, 1994). They set up ten dimensions that are presented without being numerically grounded. The dimensions are either negative, positive, or somewhere in between. They do, however, recommend the eventual grounding of these dimensions on a ten-point rating scale.

Reeves and Harmon (1994) admit that the dimensions have not been extensively tested or completely validated and "should be subjected to rigorous expert review." But, they do describe a very detailed use of the procedure to evaluate a computer-based multimedia educational program. The test indicated that users generally had a hard time operating the system and because of this, the system's utility as a training device was questioned. While this procedure may tell us something about the usability of the system, it still lacks some elements that are needed to completely evaluate a training system. The dimensions are not instruments of summative evaluation and do not evaluate system effectiveness in a quantitative manner or in comparison with other methods of teaching the same subject.

This thesis is a formative evaluation and the "User Interface Dimensions" is used to indicate areas that need improvement. The dimensions will help determine an initial measure of effectiveness by evaluating the usability of the system.

C. SIMULATIONS AND INSTRUCTIONAL TECHNOLOGY

The U.S. military's use of simulation as a training device is extensively chronicled in a series of articles edited by Ellis (1986). Included in this series are articles on needs assessment, training system design, evaluation, and validation. All the articles emphasize computer-based or simulator-based training that, when combined, resemble Goldstein's (1993) approach to training. Although most of the evaluation procedures are summative, the need for separate formative evaluation prior to implementation is emphasized. A review of training devices and computer-based training in the military is presented that provides a history of military uses, deficiencies in training devices, effective uses for computer-based training, and other issues relevant to the development of these systems. The following sections are based on findings by Ellis (1986) and were used to generate assumptions for this thesis.

1. Ease-of-use

Ellis (1986) found that ease of use and properly implemented training devices are essential to the effectiveness of training systems. This finding agrees with the assumptions behind the development of Reeves and Harmon's "User Interface Dimensions" and the use of them in this thesis. Johnson (1994) used the dimensions to conduct a formative evaluation of the IDCTT during its implementation. The student responses to the "User Interface Dimensions" indicated that the IDCTT had a very appropriate user-system interface. Johnson found that the students were receptive to the training and found it easy to use. Baumann, et al. (1996a) conducted a program review of the IDCTT that validated Johnson's (1994) findings. In the program review the researchers also used the "User Interface Dimensions"

and determined that the IDCTT was perceived as easy to use. During implementation of the TPCT, this research also used the “User Interface Dimensions” to evaluate the system’s usability. The assumption for this research was that problems with usability would inhibit the training system’s effectiveness.

2. Touchscreen Monitors and Graphics

Although Johnson’s (1994) IDCTT results were generally favorable, there were some needed improvements noted. The touchscreen monitor was difficult for students to operate and was evaluated as a major problem in the system. Ellis (1986) found that powerful computer graphics and touch screens are important and desirable parts of a computer-based training system. Because of Ellis’ assertion and Johnson’s finding, the touchscreen monitor for the TPCT was closely evaluated during this research. Touch sensitivity must be set to a usable level and the graphics for a touchscreen monitor must be integrated in a usable and understandable way. If the buttons are too small, the user will have a hard time selecting the appropriate response item. If the graphics are hard to see or not clear, the user will be unable to find the appropriate response item. So, not only do the graphics provide important “attention value” (Wetzel, et al. 1994), but they are also an essential element in the interactivity of the system.

Fletcher’s (1990) research indicates high utility for interactive video training. Fletcher (1990) reviewed 28 studies and concluded that “higher levels of interactivity were associated with higher levels of achievement.” Fletcher (1990) also came to the conclusion that interactive video-based training can be more efficient and more effective than conventional training methods. With increases in technology comes the ability to increase the graphic

capability of a training system and this should enhance realism in an interactive video-based training system. This thesis is concerned with the trainees' perceptions of system realism and how this affects the interactive capability of the system. Other technological advances including more computer power, voice recognition, and high levels of fidelity enable computer-based systems to increase levels of realism (Ellis, 1986).

3. Fidelity

Ellis (1986) determined that fidelity is important to the training system, but the level of fidelity must be consistent with the training requirements. Fidelity is also emphasized as a major component in simulation training technology by Wetzel, et al. (1994). But, they also caution that interactive training systems based on video be developed with a critical review of the need for fidelity. Functional fidelity (the amount a system acts like the real thing) is considered an important element in the effectiveness of a training system. But, the question is raised as to whether simulations must also look like the real thing (physical fidelity) to be effective. Studies cited in Wetzel, et al. (1994) indicate that extremely low or extremely high levels of fidelity can actually impede the learning process for the beginning learner[5]. But, "[a]s students become increasingly sophisticated, better learning is achieved with increasingly higher fidelity instruction that, these students are better prepared to process" (Wetzel, et al. 1994). The assumption in this thesis is that the trainee is not a "beginning learner" and that evaluation of both functional and physical fidelity will indicate if the system is productive.

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[5]The definition of "beginning learner" as well as definitions of high and low levels of fidelity are not expanded on by Wetzel, et al. (1994).

4. Trainee Perceptions

The IDCTT scenario was considered realistic and the high fidelity of the system was responsible for student perception of the trainer as an effective training method (Johnson, 1994). According to Ellis (1986), adverse perceptions of the training system by the trainee will result in poor training outcomes. Johnson found that the students were receptive to the training and concluded that this was a factor in the system's effectiveness. Baumann, et al. (1996a) concurred with Johnson's conclusion and noted that the training was perceived as valuable. This thesis looks at pre-training perceptions of simulation training and follows up with the trainees' perceptions of the TPCT in various areas. If the trainees perceive the TPCT as an effective training method, the indication is that there is less possibility of the system producing poor outcomes. Negative perceptions by the trainees led this research to look for causes and possible corrections. Of particular interest is the trainee's perception of stress induced by the trainer.

5. Stress and Decision Making

The TPCT was designed as a high-fidelity fast-paced multimedia system that creates a stressful environment in which decisions are made. Decision making under stress is the "job response" that the training system is intended to enhance. Computer-based training can be an effective means to "fine tune, integrate, and strengthen job responses" (Ellis, 1986). But, "[o]ne of the most difficult topics to quantify in training is the amount of stress in an environment and its effect on an individual's ability to make decisions" (Fuller, 1993). Stress induced by the system is intended to acclimate the trainee to the decision making process in a stressful environment. The acclimation to stressful environments combined with expert

knowledge and confidence will reduce the perceived level of stress and enhance performance (Heslegrave & Colvin, 1996). But, the challenge in this research was how to determine if the system was producing appropriate levels of stress.

The "NASA-TLX" was developed to assess the relative importance of six factors in determining how much stress or pressure was experienced during a task or exercise (Hart & Staveland, 1988). The "TLX" is a self-report mechanism that measures perceived amounts of: 1) Mental Demand, 2) Physical Demand, 3) Temporal Demand, 4) Performance Demand, 5) Effort Demand, and 6) Frustration. These factors were validated as effective in identifying variations in stress and diagnosing sources of stress within a task (Hart & Staveland, 1988).

The ability of the "TLX" to identify sources of stress within a task or system was an important factor in a review by Hill (1992). Four subjective rating measures of stress were compared by Hill, and the "TLX" was determined to provide the best source for determining source of stress in a task or system (1992). Because of the validation of the "TLX," Hill's assertion of its usefulness, and use of the "TLX" by Johnson (1994) and Baumann (1996a), it was used in this research to determine the stresses that are created by the TPCT system. Evaluating the stress induced by the TPCT system will determine if the system is operating as intended. But, it does not address the question of the effectiveness of these stressors. Effectiveness will need to be evaluated in future summative evaluation.

6. Effectiveness and Efficiency

Computer-based training provides a means to effectively train otherwise unsafe or economically impossible tasks (Ellis, 1986). This research is not looking at outcome-based effectiveness or cost savings. But, the literature review provides clues as to where a system

may need evaluation during implementation to enhance the possibility of effectiveness or prevent costly redesign of the system after implementation. Offering words of caution, DeBloois (1988) indicates that development of an effective interactive multimedia training system is a complicated and time-consuming project. But through the review of 30 studies, DeBloois (1988) found a variety of interactive multimedia training systems were effective and efficient. Of particular interest in this thesis are the results of the "VISTA 1982" study that used videodisc training for leadership skills and the "IBM Management Training 1986" study that used videodisc for management training. In each of these studies DeBlooise (1988) reported that the videodisc training was significantly more effective compared to more traditional forms of training, including role playing. Because the TPCT is designed to enhance leadership and management skills (i.e., decision making) the results of these studies indicate that the use of videodisc training is a reasonable method to use.

Johnson's (1994) summative evaluation compared student performance in the IDCTT trainer with performance in a "mock-up" trainer system that was already in place. Comparing the performances of students in the study, Johnson concluded that the IDCTT was more effective than the system already in use. Baumann, et al. (1996a) conducted a program review of the IDCTT that validated Johnson's (1994) findings. In the program review the IDCTT was determined to be mentally demanding and to produce high levels of stress and frustration (Baumann, et al. 1996a). These researchers also concluded that the IDCTT was more effective than the current "mock-up" trainer, that multiple scenarios are needed, and that the system provided valuable training. Since the TPCT is based on the IDCTT, similar results were expected and similar measurement instruments could be used.

A cost benefit analysis was conducted of the IDCTT system for Naval Sea System Command (NAVSEA, 1996). The draft report concluded that the IDCTT was cost effective relative to current training methods, and that there was future utility for the system. Included in this analysis was an endorsement for future scenarios addressing the recommendations of Johnson (1994) and Baumann, et al. (1996a). The need for scenario variety in the IDCTT prompted a goal for this research to specifically look for recommendations for new and varied scenarios for the TPCT.

The Fuller Decision Index (FDI), a quantitative measure of proficiency for the IDCTT, was used to support claims of effectiveness. The FDI "is a decision making quality measurement system that was developed with the goal of objectively and statistically deriving expert performance standards for the IDCTT" (Fuller, 1993). Although the FDI was not used in this research, Fuller's review of decision making theory and stress provided background. The IDCTT is the predecessor to the TPCT, and a review of the literature on the IDCTT provided direction for this thesis.

Johnson's (1994) formative evaluation of the IDCTT laid the groundwork for this thesis. Johnson evaluated the IDCTT with the "User Interface Dimensions," the "NASA Task Load Index" ("TLX"), and survey responses from students. Students were more responsive to the interactive multimedia training and it "promoted greater learning, produced significantly more stress, and stimulated students" (Johnson, 1994). The student responses to the "User Interface Dimensions" indicated that the IDCTT had a very appropriate user-system interface, and the responses to the "TLX" indicated perceived high levels of temporal demand on the students. The fast pace of the program caused minor problems that were

remedied by students conducting trial runs on the system. The students indicated that the system was limited and there was a need for more scenarios and different ship classes. The preceding items are not inclusive of Johnson's findings, but they represent some of the major problems that were kept in mind when developing the methodology for this thesis.

The literature reviewed in this section provided the foundation from which this research was designed. Before the methodology and use of the tools mentioned in the literature review can be discussed, the following chapter presents a complete description of the TPCT system.

III. TACTICAL PATROL CRAFT TRAINER DESCRIPTION

The Tactical Patrol Craft Trainer (TPCT) is an interactive multi-media computer-based trainer designed to deliver a realistic full fidelity and analog video training scenario. The trainee sits (but could stand) in front of two 20" touch screen computer monitors that create a semi-virtual environment simulating the actions of a PC commanding officer. Unlike a total virtual environment, the TPCT trainee is subject to the external environment. The physical presence of the instructor, room temperature, and outside noises could potentially distract the trainee during the scenario. The system currently has one scenario and the intended trainee is a prospective PC commanding officer, normally a Navy lieutenant, en route to PC command. The TPCT instructor is not intended to interact with the trainee during the scenario but is available if problems arise. This chapter introduces the reader to the major components of the TPCT system. The three basic components are discussed: 1) hardware, 2) mission scenario, and 3) software.

A. TPCT HARDWARE COMPONENTS

The hardware components of the TPCT, as illustrated in Figure 1, consist of an instructor's TPCT rack that contains the major components to run the simulation and two monitors for use by the trainee. The TPCT rack is a multi-component system that runs the simulation. It contains four networked Central Processing Units (CPUs), a laser disk player, keyboard and mouse, and a 14-inch monitor. Before any training starts, all of the system

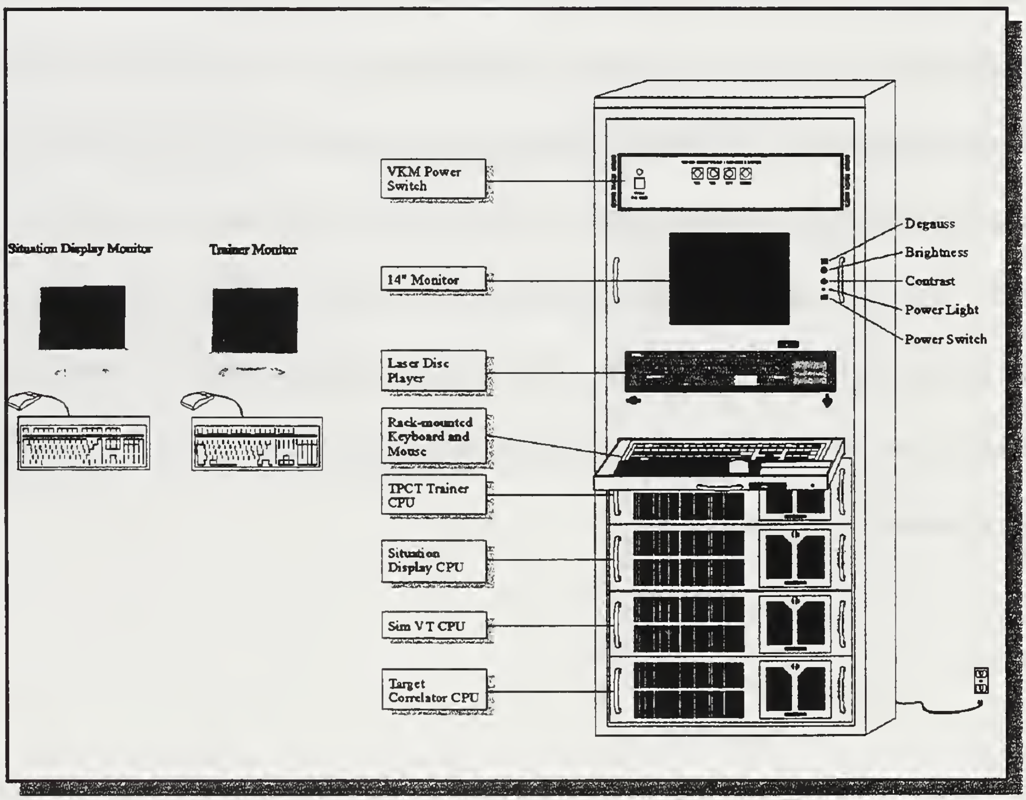

Figure 1. TPCT hardware components. Source: Instructor Guide.

components must be initialized in a precise process that must follow a strict order. The initialization process is detailed in the instructor's operating guide and discussed later in this chapter. Together, these components control all aspects of the simulation and allow the instructor to aid and monitor the trainee.

1. TPCT Trainer Monitor

The over-the-counter (OTC) monitor, shown in Figure 2, is used as the communication link between the trainee and the scenario. During testing, this monitor is positioned to the left of the trainee. This 20-inch polished-finish[6] monitor uses touch screen technology. A touch panel on the screen is used for input to the system by the trainee. A keyboard and mouse are also available but were not used during these test because they are currently considered back-ups to the touch screen technology. The trainee views video segments relevant to the

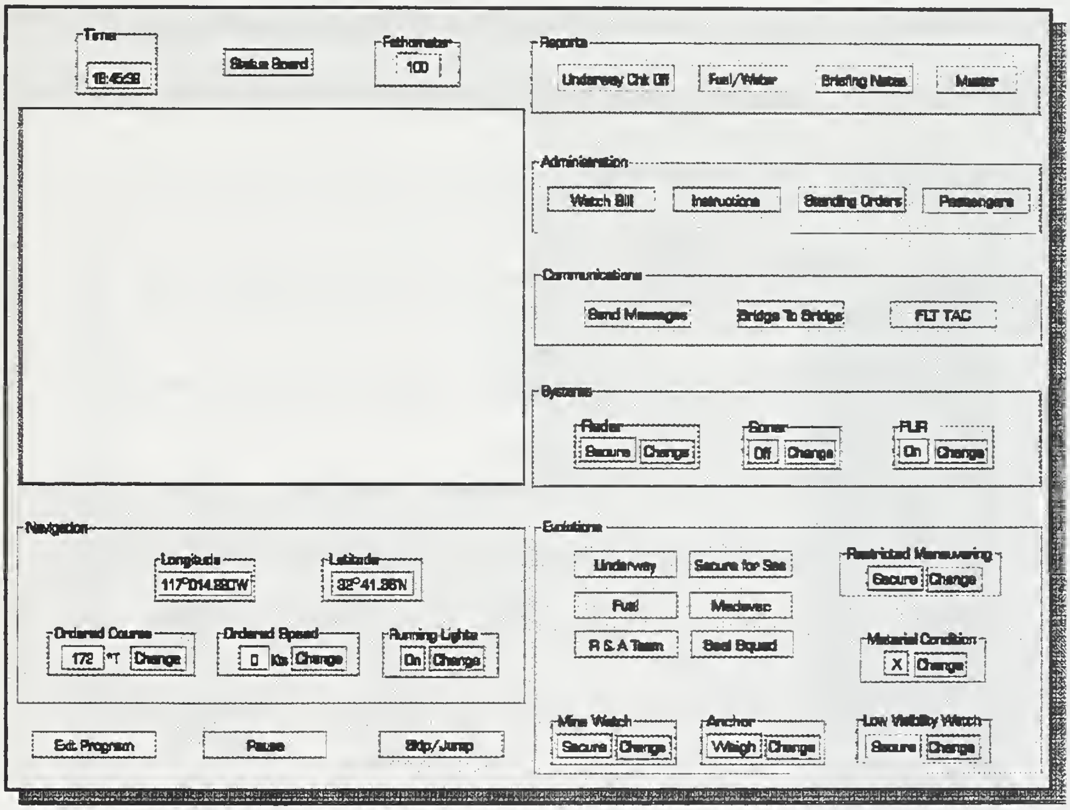

Figure 2. TPCT Trainer Monitor view during scenario. Source: Student Guide.

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[6]Polished-finish refers to the type of glass screen on the monitor. Polished-finish has a glossy look to it while an etched finish screen has a non-glare appearance.

scenario in the window on the left portion this screen. All of the video is from the viewpoint of the trainee, as if the trainee were looking at the action. When there is no relevant video segment, the area is black. Mission and ship's status information is available either directly on the screen or through opening a window by touching a screen button.

Status information includes such features as depth of the water, material condition, course, and speed. The trainee can view most of the information without opening another window. The status board and reports sections contain information that is not adjustable by the trainee. All other areas and functions on the screen can be altered by the student by pressing a button activating an on-screen menu of choices related to the desired action. Figure 3 illustrates the procedure for lighting off or securing the ship's radar. If the trainee

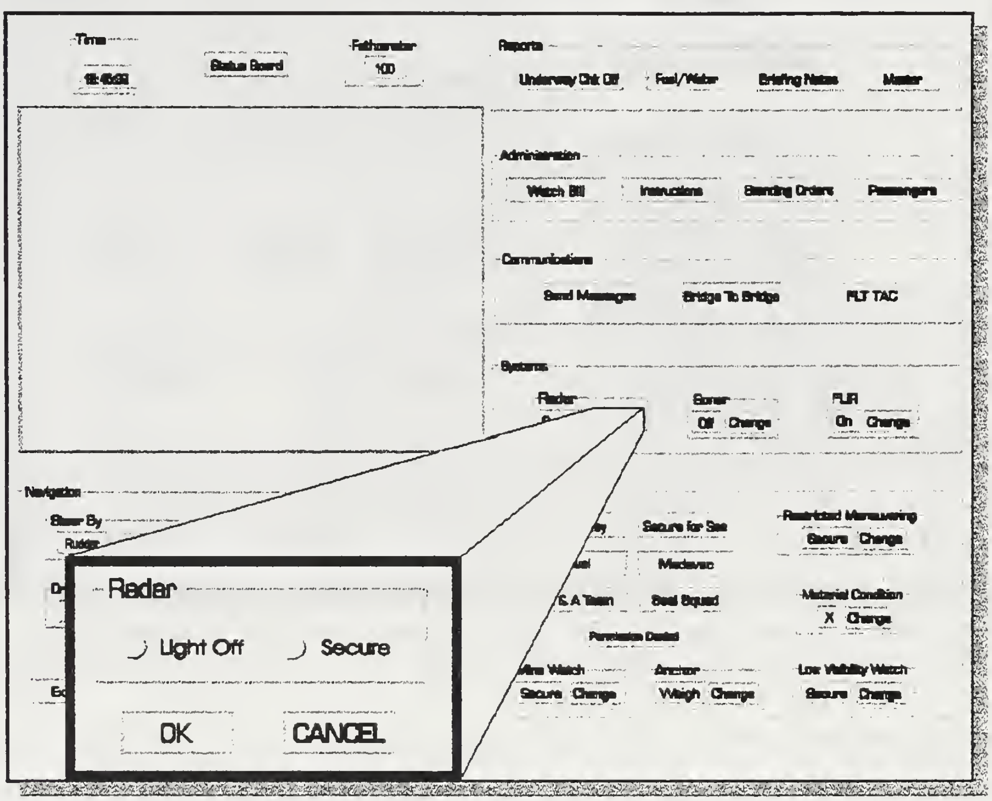

Figure 3. TPCT Trainer Monitor enhanced view. Source: Student Guide.

wants to secure the radar system, he/she would press the radar button, press “Secure” and then press “OK.” The action is not complete until OK or CANCEL is touched and no other action can be taken by the trainee while this window is open. Use of the on-screen menus is equivalent to issuing an order. The ship will respond to the request even if it leads the ship into harm’s way. Decisions are made by either ordering an action or by ignoring a request for action. At times, the video segment may recommend a course of action and the trainee can simply ignore the request. This is equivalent to a negative response. If the trainee elects to order the action, it is done through a series of on screen buttons.

2. Situation Display Monitor

This is an OTC 20-inch monitor with an etched finish and touch screen capability. The Situation Display (see Figure 4) shows the output from the Integrated Bridge System (IBS),

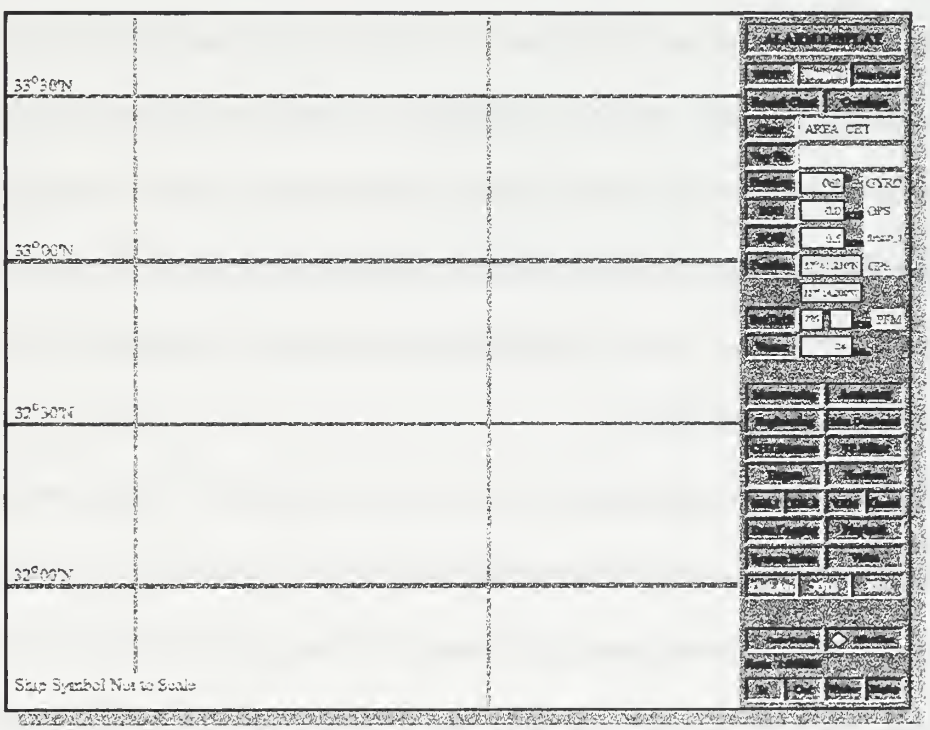

Figure 4. IBS screen from Situation Display. Source: Student Guide.

and it provides information to the trainee regarding the ship's navigation. The only inputs from the student to this system are requests for information, adjusting views (zooming in or out), or selecting plans entered previously by the TPCT system for voyage management. The IBS uses information from the TPCT system to indicate the ship's movement through the water. The TPCT's IBS display is the same that is found onboard the PC class ship. During operation of the scenario, the grid area contains an area map representation, a visual representation of the ship, and the ship's movement. This screen is positioned to the right of the trainee during testing.

3. TPCT Rack 14-inch Monitor

The 14-inch instructor's monitor in the TPCT rack allows the instructor to follow the trainee through the scenario. The instructor can watch reproductions of either the Situation Display Monitor or the Trainer Monitor and can shift between the two during the training session. The instructor sees what the trainee sees but also sees information not available to the trainee. For example, the instructor can observe the trainee's progress into a decision point area, indicated only on this screen and monitor progress without intruding on the physical space of the trainee. The monitor is also used during system initialization to conduct system analysis and testing. It can be used to monitor the actions of any of the four CPUs.

4. Laser Disk Player

The laser disk player, a generic Over the Counter (OTC) piece of equipment, is used to feed the system with analog video produced to enhance realism in the scenario. The current scenario contains video segments that appear only during appropriate times within the scenario. There is not a continuous video feed, and the laser disk is accessed only according

to scenario programing requirements. The video segments were professionally produced re-creations of events filmed onboard a PC class ship using a combination of actors and Navy members.

5. Rack Mounted Keyboard and Mouse

A standard OTC personal computer keyboard and mouse device are provided for instructor input into the system. The mouse allows for standard click and drag computer operations.

6. TPCT Trainer CPU

The trainer is an OTC Pentium®-based CPU running a Windows® NT operating system. The TPCT trainer scenario software is run on this CPU. This unit also contains software that directs the actions of all CPUs and the laser disk player in a coordinated fashion as required by the scenario software.

7. Situation Display CPU

This CPU controls the Situation Display Monitor. It is a Pentium®-based CPU running an OS2 operating system provided by Sperry, Inc. The Situation Display Monitor is the useable and visual output of the IBS. The IBS also uses the next two CPUs.

8. Simulation-Vision Technology CPU

This Simulation-Vision Technology (Sim-VT) CPU interacts with all other CPUs and the laser disk to control the video throughout the simulation. This CPU also provides the IBS navigation data to the Voyage Management System-Vision Technology (VMS-VT). It is a Pentium®-based CPU running an OS2 operating system provided by Sperry, Inc.

9. Target Correlator CPU

This CPU runs the Target Correlator Monitor (TCMON) and the Position Filter Module. This is the remaining component of the IBS using a Pentium®-based CPU running an OS2 operating system provided by Sperry, Inc.

B. MISSION SCENARIO

The TCPT scenario simulates a U.S. Navy Sea, Air, Land (SEAL) team insertion mission using the PC class ship as the insertion platform. The scenario begins with a mission brief to the trainee who is acting as the Commanding Officer of a PC. The trainee is provided with a computerized mission brief package that can be read prior to mission start and can be referred to during the mission. The trainee is then briefed in a video segment that simulates the actual brief that might occur by an operational commander prior to a mission. Both briefs contain mission plans, weather reports, enemy movement and capability reports, Standard Operating Procedures (SOPs), and other mission-critical information. After the mission brief, the system pauses until the trainee indicates readiness to start by pushing the "Start Mission" button on the TPCT trainer monitor.

The mission begins with video simulating walking aboard the ship while the crew is making preparations to get underway. From this point forward, the trainee is required to make decisions based on computer-generated situations to complete the mission. The trainee must make the decision to get underway and order it by pressing the correct button on the Trainer Monitor. All of the actual actions required by ship's company to get underway are then carried out correctly without further monitoring by the trainee. To complete the mission, the trainee must exit the friendly harbor, transit to enemy waters, insert a SEAL team in an

enemy harbor, stand off while the team conducts a mission, come back in and pick up the team, and exit enemy waters. The SEAL mission ashore is not a part of the training scenario. The trainee is expected to already have the knowledge base required to conduct this mission. But, this seemingly simple series of events becomes complicated rather quickly.

The mission scenario is conducted under strict transit time requirements while dealing with a variety of problems and decisions along the way. The problems and their solutions are known as "Decision Points" or "Teaching Points." The TPCT focuses the trainee's attention on an abundance of information requiring timely response to the many significant decision points associated with a complex scenario. Depending on the nature of the response, the scenario either shifts toward resolution or degradation that can lead to prematurely ending the scenario. Some events, video segments, and sound bites are included in the scenario to create a fast-paced stressful environment under which the trainee must make important decisions. The scenario ends as either a mission success from the correct treatment of Decision Points or discussing with the instructor the appropriate decisions to emphasize a Teaching Point.

An incorrect response to one of the Decision Points in the hour-long simulation[7] will result in ending the program either through some direct catastrophic situation or inability to meet the transit time requirements. This is not considered a failure, rather it becomes a Teaching Point that can be discussed between the instructor and trainee. The trainee can then

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[7]The mission in this scenario would take over 6 hours to complete. The simulation is shortened through the use of "warping," which advances the trainee and ship's position in the mission at an accelerated rate. During this time no actions are taken by the trainee.

restart the mission from the beginning and again attempt mission completion. The scenario used in this evaluation was not alterable, and there was no way for the trainee to start where the last attempt ended.

C. TPCT SOFTWARE COMPONENTS

Software in a multimedia system refers to the programming code that causes the system to function. This thesis does not evaluate the programming except in reference to how well it operates. The programming code, per se, is not evaluated. Flaws in the code were noted if a failure occurred during operation of the system. Each CPU in the system contains its own set of code. The three CPUs that operate the IBS were pre-programmed by Sperry, Inc. and contained no unique programming. The programming for the TPCT Trainer CPU was new and contains the innovative networked link to the IBS system. This CPU facilitates the multi media interactive service.

Integral to the software is the documentation for the system including the operating guide, the instructor guide, and the student guide. These documents were evaluated as part of this thesis. They were draft documents that needed testing and revision. The operating guide served to provide instructions to the instructor for operating the system, primarily for starting the CPUs and securing them after training. The instructor guide gave detailed scenario and training information with procedures for conducting the training. The student guide provided the student with a system overview and information on how to operate the system. All of these documents were draft copies.

IV. METHODOLOGY

This chapter describes the methodology used in this research. The methodology evolved as a result of pre-testing the Tactical Patrol Craft Trainer (TPCT). An explanation of this evolution is provided. Detailed in this chapter are the subjects, data collection instruments, and procedures used to conduct the beta testing.

A. SUBJECTS

The proposed methodology was originally designed to compare the performance of approximately 10 Subject Matter Experts (SMEs) with two different groups of trainees: 1) the four current Patrol Craft (PC) Commanding Officers in San Diego, and 2) about 30 Navy Lieutenants[8]. The subject matter experts are Naval officers who have had command at sea and thus could establish a baseline for evaluating the performance of trainees on the system. The assumption was that the SMEs would complete the TPCT scenario in a specific number of runs and this could be compared to the number of runs required to complete the scenario by the trainees. This proposed comparison became problematic early in the research.

The availability of test trainees, especially SMEs, was severely limited because of work schedules of potential subjects. There were no SMEs available during the period of testing for this research. An even more limiting factor, discovered in pre-testing, was the inability of the trainees to complete a successful scenario run in a 3-hour time frame.

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[8]These officers are representative of officers who might use the TPCT en route to command of a PC class ship.

Two test subjects, from the same pool of available waterfront personnel as the actual test subjects were pre-tested on the TPCT to collect pilot data. The pre-testing allowed the researcher to evaluate the time required to conduct each training session. Because the TPCT software requires the trainee to start from the beginning of the scenario after missing a critical decision point, it increased the testing time beyond the expected 3 hours and beyond the time most subjects could provide. Trainees were arranged by SPECWARCOM and were made available for a 3-hour training session. Another difficulty was the time required for trainees to complete the survey, review the student guide, and learn the basics of the Integrated Bridge System (IBS). Almost 1 hour of the allotted time was used to complete these aspects of the testing. Trainees who had not completed the PC Commanding Officer training pipeline were not familiar with the IBS prior to using the TPCT[9].

Navy commands in the area were contacted and asked for volunteers. Volunteers were also solicited from within SPECWARCOM. In the end, 18 test subjects participated in this study from various commands in the San Diego, CA Naval District. Seventeen were U. S. Navy officers and one was a senior enlisted member from a PC class ship with Officer Of the Deck (OOD) qualification[10]. Of the 17 officers, 11 were Lieutenants, two were Warrant Officers, two were Lieutenant Commanders, one was an Ensign, and one was a Commander. The mean age of the group was 31 years old , the oldest was 45, and the youngest was 24.

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[9]The testing also revealed that IBS would not be known to the trainees for whom the TPCT was designed because IBS is not taught in the PC commanding Officer training pipeline.

[10]OOD qualification is a bridge watch station that would require the member, in the absence of the CO, to make some of the same decisions the CO would make.

The education background, commissioning source, and ship experience demographics of the test group are shown in Table 1.

Table 1. TPCT trainee demographics.

Trainee Demographic Information

	Total	Percent of Group*
Education		
BS Engineering	3	17%
BS Non-Engineering	11	61%
BA	1	6%
MS Engineering	0	0%
MS Non-Engineering	0	0%
MA	1	6%
Ph.D.	0	0%
OTHER	0	0%
Commissioning Source		
USNA	7	39%
NROTC	6	33%
OCS	1	6%
ECP	1	6%
Seaman to Admiral	0	0%
OTHER	0	0%
Ship Types Served in		
CRUDES	12	67%
AMPHIB	4	22%
CV	0	0%
AUX	2	11%
PC	6	33%
MCM	2	11%
OTHER	0	0%
At Sea Experience		
COMMAND	0	0%
XO	2	11%
Department Head Jobs		
Operations	3	17%
Deck	0	0%
Air	0	0%
Engineering	1	6%
Combat Systems	1	6%
Weapons	0	0%
Other	0	0%
Division Officer Jobs		
Engineering	15	83%
Deck	5	28%
Air	0	0%
Operations	9	50%
Weapons	1	6%
Combat Systems	0	0%
Other	2	11%

* All percentages do not total 100. Trainees may have more than one degree and could have experience in more than one ship or job class. Education and Commission Source also have missing data. This figure represents only the percentage of the test subjects with that particular demographic.

The instructor during this study was a civilian contractor. He is a retired U. S. Navy Commander with OOD qualification and experience in the development of the PC class ship and the development of the TPCT. The instructor is also qualified as a Navy Master Instructor and provided invaluable insight into the training process that resulted in a more comprehensive review of the instructor's guide.

B. DATA COLLECTION INSTRUMENTS

A TPCT training data package was developed for this research. The complete package, which consists of pre-and post-training survey questions, interview questions, and instructions, is included in this thesis. A group of 10 Naval Postgraduate students evaluated the training data package for clarity and understanding prior to use in this research. Field notes taken during the testing and a report generated by each TPCT run were used in this research to compare each trainee's survey responses. Additionally the items discussed below, which were contained in the TPCT training data package are used to answer the research questions .

1. Demographic Data

Demographic data were collected using the "TPCT Trainee Demographic Data" sheet from the TPCT training data package (see Appendix A). In the originally proposed methodology, the demographic information was intended to provide data for the development of a model that would predict performance in the simulator. The proposed model was patterned after a model based on demographic factors that Cymrot (1990) concluded were linked to performance outcomes of naval officers who qualified as Surface Warfare Officers (SWOs). The qualification process includes tasks that resemble some of the tasking items in

the TPCT such as decision making during shipboard maneuvering. Included in Cymrot's study were commissioning source, education, and shipboard experience. As discussed earlier in this thesis, the planned analysis of performance was abandoned due to inability of the participants to complete the scenario.

2. TPCT Pre-Training Information

The pre-training information consists of two questions developed for this research to examine prior experience with training simulators (see Appendix B). Prior experience was examined to check for possible bias in the sample group. It was first hypothesized that among SWOs there would not be very much simulator experience and that positive experience with simulators would bias the trainee's impression of the TPCT toward more favorable responses. The first question asks if the trainee has ever used an interactive training simulator. Question two is only answered if the trainee responds positively to question one. Question two asks the trainee to rate the prior experience on a scale of one to five, with negative and positive as the anchor points, and ineffective or effective as the anchor points for the second part of the question. The last part of question two asks trainees for a "yes" or "no" answer on whether they felt training simulators were practical devices for future use in the Navy.

3. Post-Training Questions

A set of nine questions was developed to be administered orally after completion of the training (see Appendix C). The first five questions from this set were administered, then the trainee was given a battery of survey questions to complete (which is discussed next), then the trainee was asked the remaining four questions from this set. The first five questions ask the trainee specific questions about pressure (not stress) felt during the simulation, inadequacy

in the student guide or instructor's explanations, perceived learning, and perceived benifits from the training experience. The first three questions of the remaining four ask specific questions regarding levels of stress, causes of stress, and attitude toward the stress caused by the trainer. The last question solicits an unstructured response by requesting recommendations and additional comments.

4. NASA Task Load Index

The "Task Load Index" ("TLX") was developed at NASA (Hart & Staveland, 1988) to assess the relative importance of six factors in determining how much workload[11] was experienced during a task or exercise. The "NASA-TLX" was modified from its original form and used to evaluate the task loading of trainees in this simulation (see Appendix D). The original scale is a ten-centimeter-long line, anchored at the low end at 0 and at the high end at one-hundred millimeters, scored by measuring the subject's mark on the line to the nearest millimeter. Professor Baumann, University of Illinois, who used the "TLX" to evaluate the Integrated Damage Control Training Technology (IDCTT), recommended changing the scale because "measuring things to the nearest millimeter seems like over-kill on a self report measure and struck us as likely to just introduce more random fluctuation" (1996b). The scale was modified to a 10-point scale anchored at the low end at zero and at the high end at 10. The modified "NASA-TLX" contains five two-part questions and one single-part question. The questions are divided into the following task loading factors: 1)

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[11]"Workload" and "task loading" are generic terms that describe the pressures, effort, and stresses, both mental and physical, that occur when a person is involved in a task.

Mental Demand, 2) Physical Demand, 3) Temporal Demand, 4) Performance Demand, 5) Effort Demand, and 6) Frustration. The TPCT was designed to induce stress during the decision making process and these factors are used to measure how well the system accomplishes this goal. With the exception of "physical demand," a measure of effectiveness for the system is scores above the midpoint of "5" on the scale. The criterion for effectiveness is arbitrary based on scores above 5 indicating that the demand was perceived as high rather than low.

5. User Interface Dimensions

The "User Interface Dimensions" developed by Reeves and Harmon (1994) was used as modified by Johnson (1994) for use in evaluation of the IDCTT and further modified for use in this research (see Appendix E). This research used the eight dimensions as modified by Johnson and further changed the scale of one to 11, to zero to 10 for ease of analysis. The eight dimensions are: 1) Ease of Use, 2) Navigation, 3) Cognitive Load, 4) Mapping, 5) Knowledge Space Compatibility, 6) Information Presentation, 7) Media Integration, and 8) Overall Functionality. Each dimension is addressed as a separate question designed to provide a measure of the adequacy of the human-system interface. A low score for any one dimension can provide answers to where the system may need specific improvement. Scores above "5" on the scale indicate an appropriate interface. The criterion was established based on the original scoring that indicated marks to the right of center were positive.

6. TPCT Post-Training Information Survey

The post-training information survey was developed to provide additional input for answering the research questions in this thesis (see Appendix F). This survey contains 16

questions that ask the trainee to rate the system's ease of use, the scenario's complexity, the comfort level of the environment, usefulness of the system as a trainer, effectiveness of some elements, problems encountered, satisfaction, and recommendations. Although they were developed using Johnson's (1994) "STUDENT IDCTT SURVEY" as guidance, all of the questions in this survey are specific to the TPCT system and its scenario. Each question either provides specific input into areas of the trainer that may need improvement or provides an additional measure of effectiveness based on trainee satisfaction.

C. PROCEDURE

An oral background introduction to the system was conducted by the SIR instructor and each trainee was informed of the thesis research involved. As part of this introduction, the following statement was read to each trainee:

> During this training period you will be assisting in the beta test process of the TPCT. Your cooperation in completing pre- and post-training surveys will be greatly appreciated. The information gathered in the surveys is for research purposes only, to assist in the installation of the TPCT. In no way will your inputs be utilized for other than research. Your candid comments are welcomed and encouraged. Your performance is being examined for the purpose of evaluating the TPCT system.

Prior to testing, each trainee was asked to complete the demographic and pre-test survey portion of the TPCT training data package in accordance with the facilitator's guidelines section of the training data package (see Appendix G).

After the introduction, the researcher acted solely as an observer, taking notes on comments and questions from the trainee, physical actions of the trainee, interactions between the trainee and the instructor, and responses by the instructor to the trainee's questions. Each trainee was allotted a 15-30 minute period to review the student guide and ask questions. A

complete introduction was then given to the student by the instructor that covered operating the system, operating the IBS, and what role the instructor would play.

The instructor's role changed after two trainees when it was realized that more guidance was needed to understand key operating features of the system. The most prevalent change was the inclusion of a more detailed brief on the IBS and instructor assistance in this area. From this point on, the instructor operated the IBS for the student if necessary. If the trainee made a decision that required the use of the IBS, recognized that IBS was needed, and did not know how to operate the IBS to implement the decision, the instructor could be asked for assistance. The instructor would only guide the trainee on the operating procedure required to implement the decision, not in the decision making process. The trainee could ask questions, but the instructor refrained from answering them as much as possible to maintain the autonomous decision making situation.

Each trainee participated in the scenario until a decision point was missed, and the system indicated an error. The instructor would then debrief the mission to the point of the error, explaining and discussing the decision and training points to this point in time. The trainee could also ask system operation questions and comment freely on the system. After completion of the debrief, the scenario was restarted from the beginning, and the trainee would again proceed until a decision point was missed. Each trainee was usually only able to participate in the scenario twice, at the most making it half-way through the scenario on the second try, during the allotted 3-hour training session.

After completion of the debrief for the last scenario try, the trainee was asked to complete the post-training evaluation. The post-training phase consisted of five structured

interview questions followed by completion of the "Task Load Index," "User Interface Dimensions", and TPCT Post-Training Information survey portion of the TPCT training data package. The researcher was available to answer questions concerning the survey during this time. After completing the survey, the trainee was then interviewed with four more questions, the last being an open-ended request for recommendations and comments.

At the completion of each training session, the researcher and the instructor discussed the session and recommendations that were made. The TPCT also generated a report for each session on the actions taken by trainee. The report indicated Decision Points reached and actions completed by the trainee. The results of the observation, survey results, interviews, and scenario reports provide the data for the formative evaluation of the TPCT. The formative evaluation of the data are presented and discussed in the next chapter.

V. DATA PRESENTATION AND ANALYSIS

This chapter presents the data obtained using the Tactical Patrol Craft Trainer (TPCT) training data package,[12] the researcher's observations, and the trainees' comments. The data are presented as frequency distributions for the quantitative elements of the Pre-Training survey, "NASA Task Load Index" ("TLX"), "User Interface Dimensions," and TPCT Post-Training Information survey. Additionally the statistical mean and standard deviation are presented as appropriate.

Because of their qualitative nature, the observations and comments are summarized based on significance and frequency. The significance of the observations or comments are judged subjectively by the researcher and influenced by the research questions outlined in this thesis. Frequency is not a criteria for inclusion, but it does contribute to significance. Comments from trainees are summarized.

A. TPCT PRE-TRAINING INFORMATION

The Pre-Training Information survey (see Appendix B) was developed to determine the computer-based simulator experience level of the trainees and examine any preconceived opinions about this technology prior to introduction to the TPCT. Question #1 asked the trainees if they had ever used an interactive training simulator (yes or no). Ten of 18 (56 percent) of the trainees indicated that they had prior simulator experience. The trainees that answered yes to question #1 were asked to answer the three parts of question #2. Question

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[12]The contents of this package are detailed in Chapter IV and included in this thesis as Appendices A thru G.

#2A asked the trainees to rate their previous experience as negative or positive. These ten trainees rated their experience as positive with a mean score of 4.5 with a standard deviation of 0.71 on a scale of 1 to 5. Question #2B asked the trainees to rate the previous training as ineffective or effective. These ten trainees rated the training as effective with a mean score of 4.1 with a standard deviation of 0.57 on a scale of 1 to 5. One-hundred percent of the group with prior experience also answered "yes" to question #2C, indicating that they envisioned future applications for computer-based simulator training in the Navy. The number of trainees in the TPCT test group with prior simulator experience was higher than expected, and the experiences were positive. This finding may bias the results of the research because trainees who enjoy the type of training they are involved in are more likely to respond favorably to questions about the effectiveness of the training (Ellis, 1986).

B. TASK LOAD INDEX EVALUATION

The "TLX" developed by NASA and modified for this research is divided into six factors (see Appendix D). These factors are used in evaluating the TPCT's ability to impose high levels of various cognitive demands that contribute to stress during the decision making process. The data for each factor are presented and discussed separately.

Mental Demand experienced by the trainees is evaluated using data from the two parts of question #1 as displayed in Figure 5. The first part (A) identifies how much mental demand was required. The mean score was 7.78 with a standard deviation of 1.35. The second part (B) identifies the degree of difficulty in mental demand. The mean score was 7.11 with a standard deviation of 1.32. The trainees responded that the task required high levels of mental activity and was demanding.

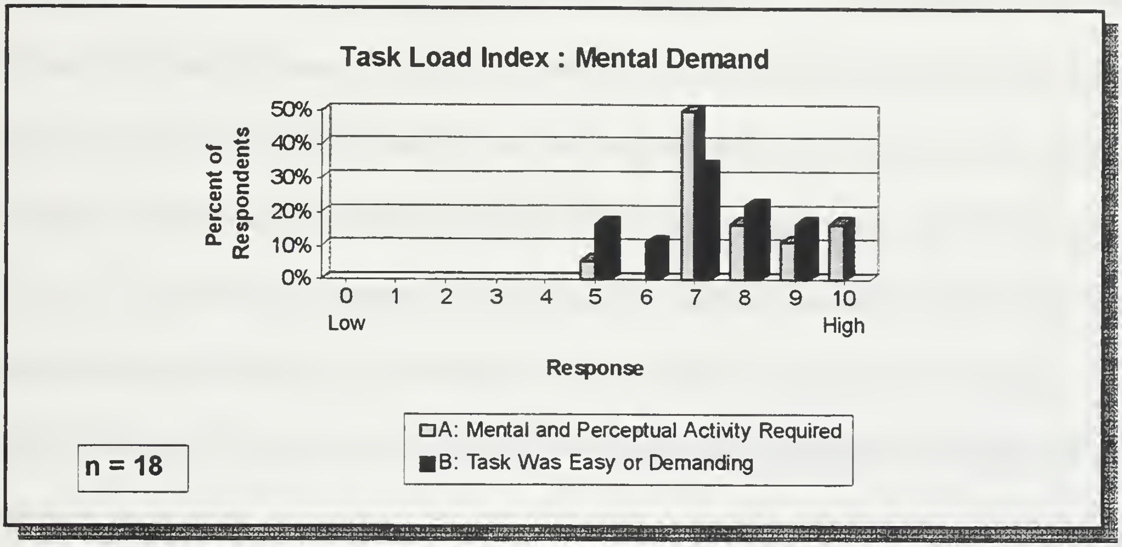

Figure 5. Task Load Index questions 1A and 1B percentages.

Physical Demand experienced by the trainees is evaluated using data from the two parts of question #2 as displayed in Figure 6. The first part (A) identifies how much physical activity was required. The mean score was 1.28 with a standard deviation of 1.23. The second part (B) identifies the difficulty of physical activity. The mean score was 3.89 with

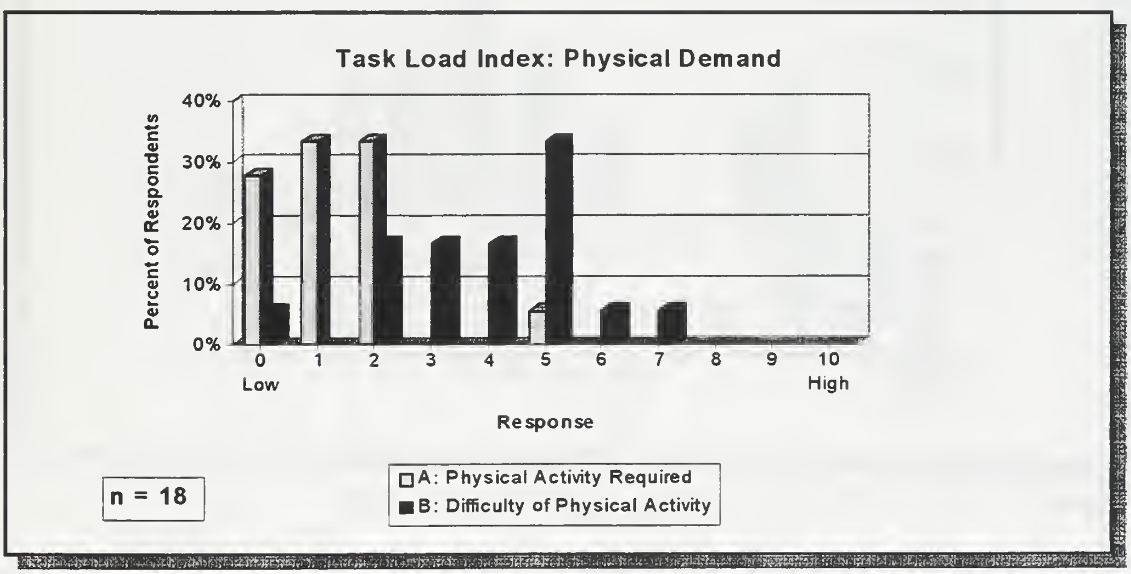

Figure 6. Task Load Index questions 2A and 2B percentages.

a standard deviation of 1.75. The trainees respond that the task required very little physical activity. But, even though the data show the physical activity was not difficult, it should be noted that over 40 percent of the respondents scored the difficulty at or above the set criterion of 5.[13] This rating may be caused by an observed variance in the trainee's ability to easily operate the touchscreen monitor (the only physical aspect of the trainer).

Temporal Demand experienced by the trainees is evaluated using data from the two parts of question #3 as displayed in Figure 7. The first part (A) identifies how much time pressure the trainee felt due to the pace of the task. The mean score was 6.22 with a standard deviation of 2.05. The second part (B) identifies whether the trainee viewed the pace of the

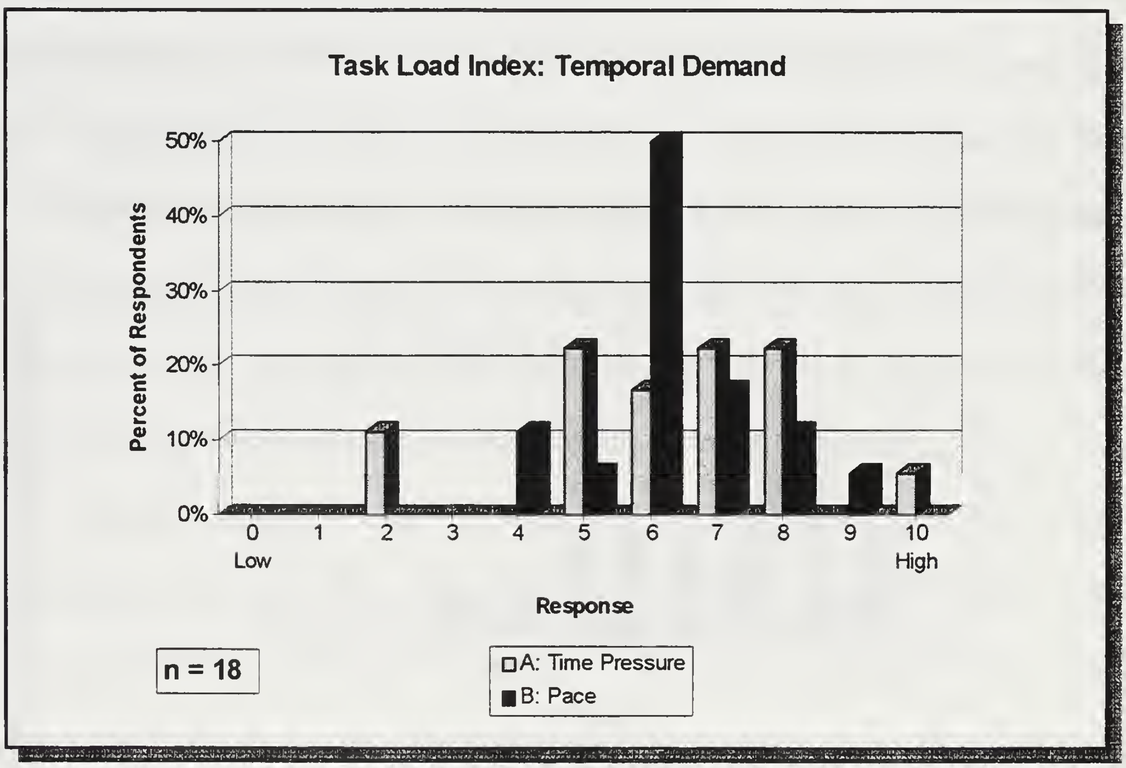

Figure 7. Task Load Index questions 3A and 3B percentages.

[13] The criterion for evaluating survey instruments scaled 0 to 10 was established in Chapter III. Low and high are determined relative to the midpoint of 5 on the scale.

task as slow or rapid. The mean score was 6.28 with a standard deviation of 1.27. Although both parts indicate high temporal demand, variation in the amount of time pressure felt is distinctive because the TPCT scenario was designed to create a highly time-sensitive environment. The data show that the pace is rapid with most responses occurring at or above a score of 6, but the resulting pressure experienced by the trainees varied considerably with over 30 percent responding at or below the criterion of 5.

Performance Demand experienced by the trainees is evaluated using data from the two parts of question #4 as displayed in Figure 8. The first part (A) indicates how successful the trainee felt in the accomplishment of the tasks. The mean score was 6.28 with a standard deviation of 2.47. The second part (B) identifies how satisfied the trainee was with individual performance. The mean score was 4.67 with a standard deviation of 2.68. The data indicate

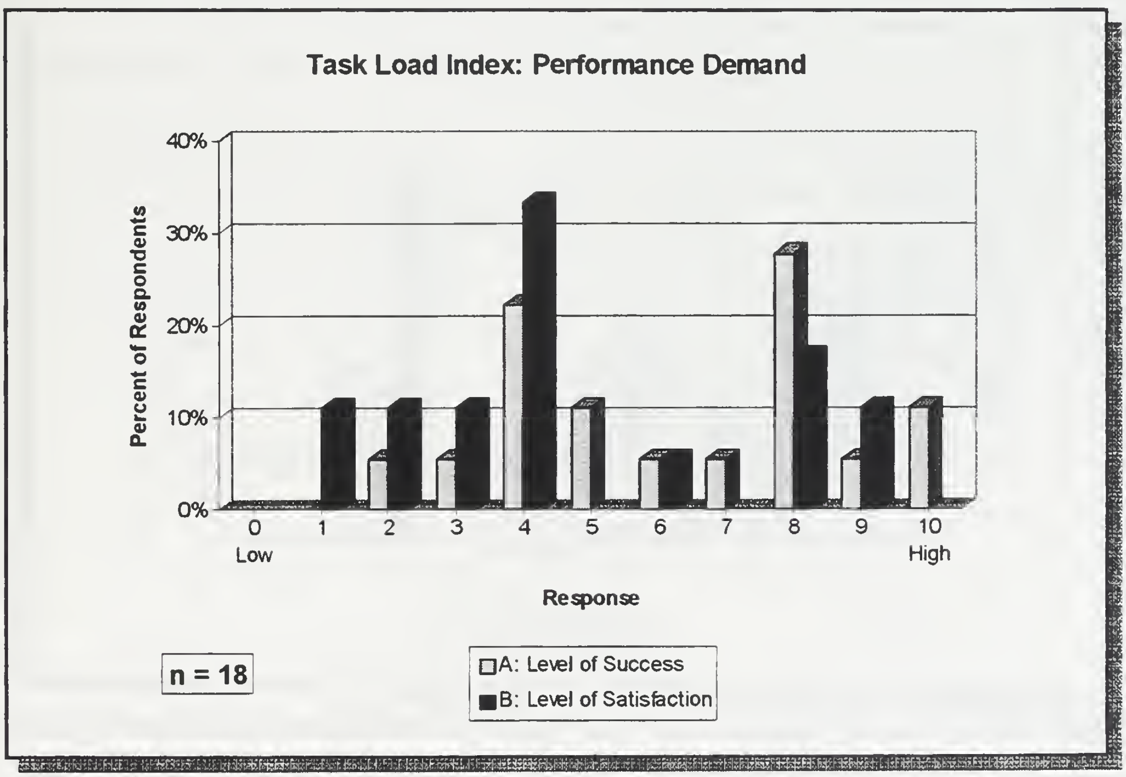

Figure 8. Task Load Index questions 4A and 4B percentages.

that the trainees generally felt more successful than they felt satisfied. However, there are large variances in the responses to both questions. The inability, due to time restrictions, to complete the scenario may have impacted this factor. The trainees may have felt some success from advancing beyond some difficult task in the scenario, yet satisfaction could be diminished because the trainee could not complete the entire scenario.

Effort Demand experienced by the trainees is evaluated using data from the two parts of question #5 as displayed in Figure 9. The first part (A) identifies how much mental effort was required to achieve the trainee's level of performance. The mean score was 6.5 with a standard deviation of 1.34. The second part (B) identifies how much physical effort was required to achieve the trainee's level of performance. The mean score was 1.78 with a standard deviation of 2.26. The data indicate that on average, the mental effort required to

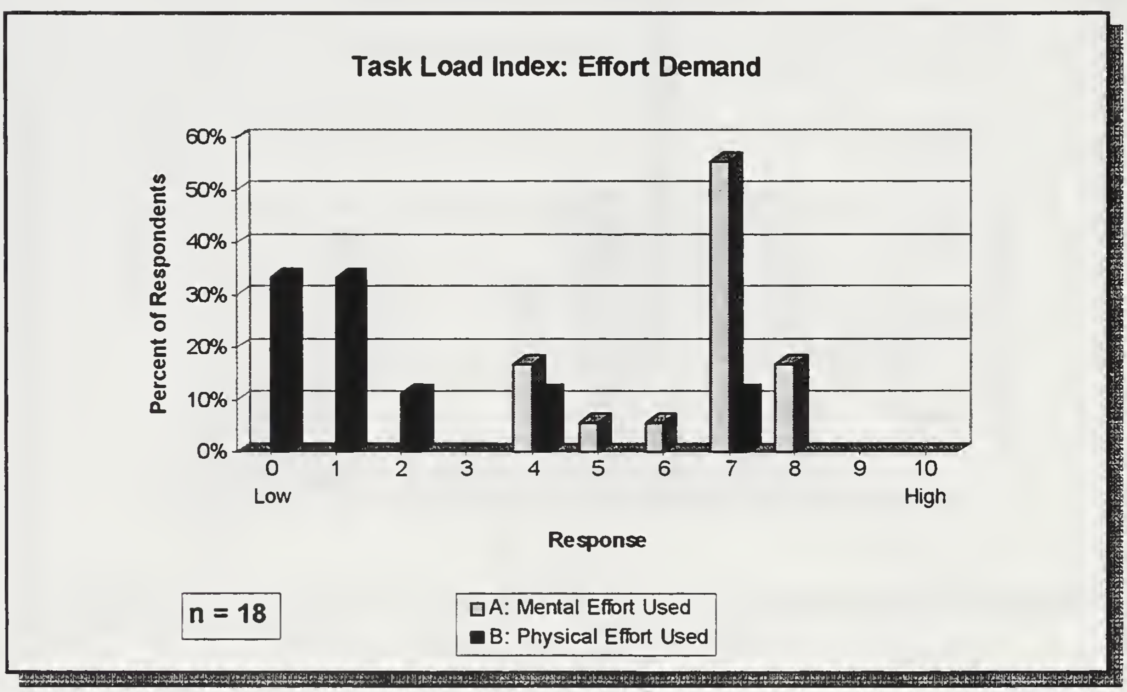

Figure 9. Task Load Index questions 5A and 5B percentages.

accomplish a level of performance was significantly higher than the physical effort. But notice should also be given to the several outliers who appeared to have some physical difficulties in performance achievement. The mental effort is expected in a computer-based simulator, but physical effort was not expected to be a factor. Difficulty with the touchscreen was reported by some trainees and may have contributed to this finding.

Frustration experienced by the trainees is evaluated using data from question #6 as illustrated in Figure 10. The data indicate levels of frustration the trainees felt during the simulation. The mean score was 5.3 with a standard deviation of 1.94 . Although the mean score is above the criterion of 5, the majority of responses are grouped around this criteria indicating that the frustration levels were not extremely high. Some trainees expressed specific frustration at not being able to finish the scenario. Other factors that could contribute to frustration are lack of experience with the Integrated Bridge System (IBS) or problems interfacing with the system.

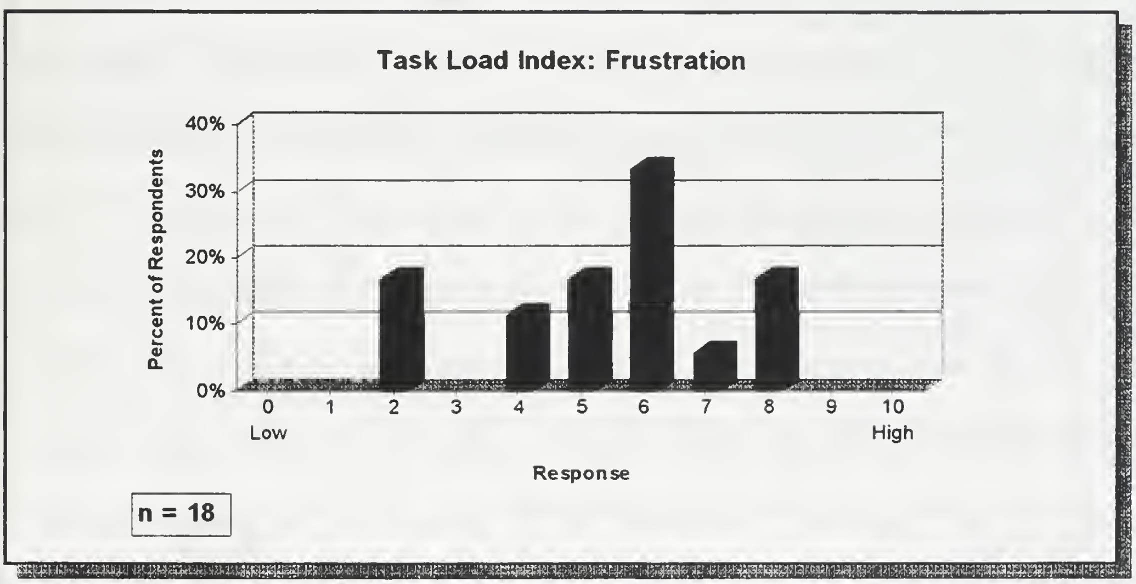

Figure 10. Task Load Index question #6 response percentages.

The cumulative results of the "TLX" indicate that the TPCT induces high mental demand and requires low levels of physical activity. The temporal demand factor is rated high, but the time pressure aspect is lower than expected. Frustration levels are within a reasonable range and should not be considered detrimental to the training process. The TPCT system appears to be effective in generating the intended stress levels of trainees.

C. USER INTERFACE DIMENSIONS

The "User Interface Dimensions" (see Appendix E) are used in this research to determine a measure of the adequacy of the human-system interface. Each scale is anchored by a negative evaluation of the interface (e.g., "Difficult to Use") at the low end, and a positive evaluation at the high end of the scale (e.g., "Easy to Use"). The mean score of trainees' responses to all eight dimensions are shown in Figure 11.

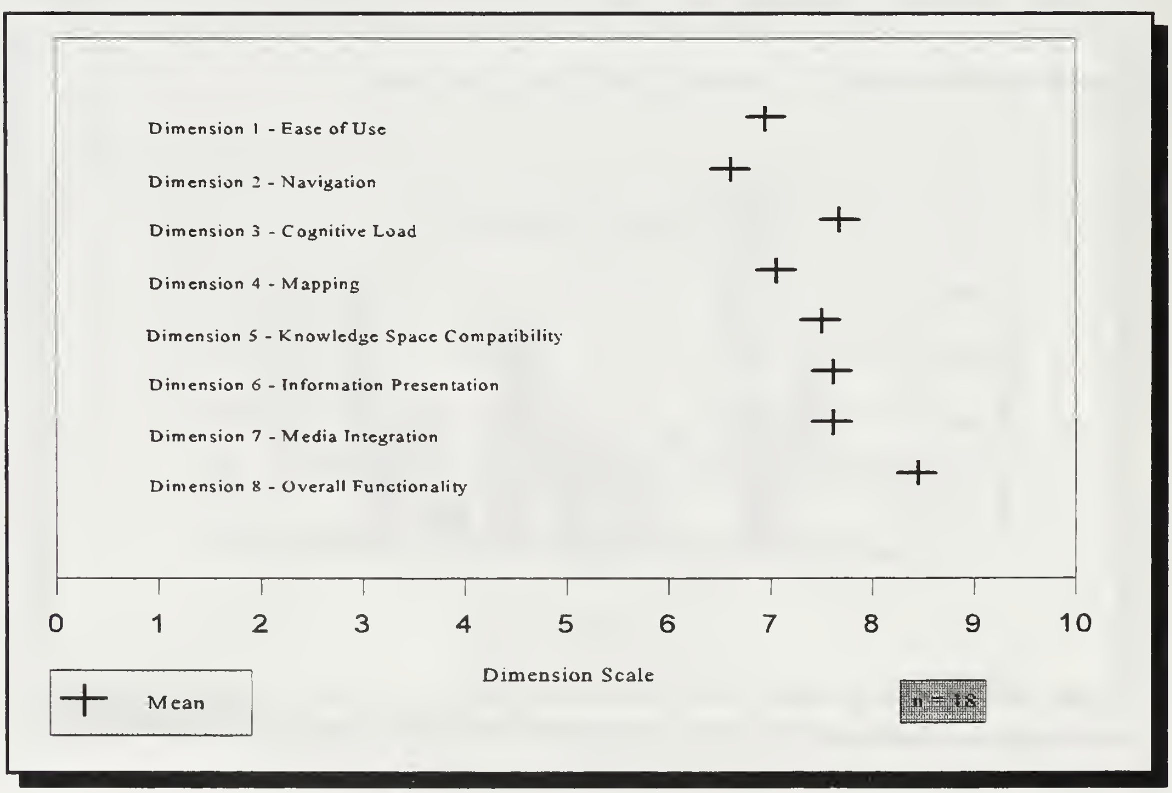

Figure 11. "User Interface Dimensions" results.

All dimensions of the TPCT were evaluated above the criterion of "5" for consideration as an adequate human-system interface. The "Ease of Use" dimension had a mean score of 6.94 with a standard deviation of 1.35. The "Navigation" dimension had a mean score of 6.61 with a standard deviation of 2.06. The "Cognitive Load" dimension had a mean score of 7.67 with a standard deviation of 1.61. The "Mapping" dimension had a mean score of 7.06 with a standard deviation of 2.07. The "Knowledge Space Compatibility" dimension had a mean score of 7.50 with a standard deviation of 1.50. The "Information Presentation" dimension had a mean score of 7.61 with a standard deviation of 1.72. The "Media Integration" dimension had a mean score of 7.61 with a standard deviation of 1.04. The "Overall Functionality" dimension had a mean score of 8.44 with a standard deviation of 1.15. Dimensions 1, 3, and 5 thru 8 were all positive with no indications of failure in the human-system interface, but the data for dimensions 2 (Navigation) and 4 (Mapping) indicated possible problems.

Although "Navigation" was not below the set criterion, it was lower than the rest of the dimensions. Over 20 percent responded at or below the criterion of 5, with two trainees responding as low as 3 on the scale. The trainees expressed concern that they were unfamiliar with the system and had to find things "on the fly." Suggestions were made to allow the trainee more time to review the student guide and allow the main screen to be accessible prior to starting the scenario for the trainee to get familiar with the buttons, their functions and contents. The low score in the "Navigation" dimension relative to other dimensions supports recommendations made by trainees to provide the trainees more familiarization with the interface before use.

Although the "Mapping" dimension's mean was well above the criterion of 5, over 40 percent of the trainees responded at or below the criterion. This variation in the dimension may be explained in two different ways. Two trainees asked for clarification of the dimension while taking the survey. This dimension was also questioned during the survey review conducted by Naval Postgraduate students. Confusion on this question may have added to its variation, but the fifth dimension was also questioned and required clarification to some of the trainees and it did not have the same large variation. Some trainees expressed a feeling of being "lost in the scenario," of "not knowing that I was behind schedule." The ability to follow the progress and keep to a rigid time line is a major training point in the system and some trainees may have evaluated the "Mapping" dimension somewhat low because they felt there should be more clues when they were falling behind. But the trainees also expressed that this was not a bad aspect of the trainer because it reinforced ideas of "keeping an eye on the big picture."

Even with possible improvements indicated by the "Mapping" and "Navigation" dimensions, the interface was perceived as appropriate. The cumulative evaluation of the TPCT, using the "User Interface Dimensions," is that it is easy to use and the trainees felt the media integration and overall functionality were good.

D. TPCT POST-TRAINING INFORMATION SURVEY

The post-training information survey (see Appendix F) results are consistent with the previous survey instruments and provide additional input for answering the research questions in this thesis. Each question is discussed in the following paragraphs.

Question 1 asks for the trainee's perception of the TPCT system's ease-of-use. The

average score was 3.9 with a standard deviation of 0.9 on a 1 to 5 scale. The results indicate that the majority of trainees perceived the trainer as easy to use. This question specifically validated the results of the "User Interface Dimensions" ease-of-use dimension and indicated that the system, as a whole, was easy to use and thus the interface was not a major problem.

Question 2 looked more specifically at the touchscreen interface to rate the trainee's perception of its ease-of-use. This was examined because Johnson (1994) found that the IDCTT touchscreen had been a problem. The average score for the TPCT was 4.17 with a standard deviation of 0.7 on a 1 to 5 scale. The results indicate that the trainees considered the touchscreen easy to use. Although earlier results indicate possible problems with the touchscreen, the results here indicate that the difficulties experienced by the trainees were not severe.

Question 3 was intended to evaluate the trainee's perception of the scenario instead of the system or interface. The results of this question's four parts are shown in Table 2.

Table 2. Post-training information survey question 3 results.

TPCT SCENARIO

SCALE	AVERAGE
Easy to Difficult	3.4
Confusing to Understandable	4.0
Slow to Fast	3.5
Unrealistic to Realistic	3.9

Scale: 1 to 5

The scenario was designed to be understandable yet difficult, fast, and realistic. The average score for each part to this question was above the midpoint of 3 and indicates that the scenario was understandable while remaining difficult, fast, and realistic.

Question 4 looks at environmental factors that may have contributed to the trainee's perception of the trainer. Because the trainer was located in a temporary area that may have proved distracting, the trainees were asked to rate the temperature, comfort level, and noise level. The trainees rated the temperature neither too cold nor too hot with an average score of 3.0 with a standard deviation of 0.34 on a scale of 1 to 5. Comfort level was scored toward "Very Comfortable" by the trainees with an average score of 3.83 with a standard deviation of 0.62 on a scale of 1 to 5. The noise level did not seem to disturb the trainees who indicated that it was neither too quiet nor too loud with an average score of 3.0 with a standard deviation of 0.34 on a scale of 1 to 5. So, the trainees felt comfortable and the environment should not have affected their perceptions of the system.

The TPCT system was designed as a trainer for the prospective PC class Commanding Officers and the trainees were asked in question 5 about the utility of the system to this end. Did the trainees think that the system was an effective trainer? The response to this question was very positive with an average score of 4.72 with a 0.46 standard deviation on a scale of 1 to 5. The trainees also responded favorably to the question (number 6), which asked if there was utility for this type of system in other decision making training. The response to question 6 was an average score of 4.56 with a 0.70 standard deviation on a scale of 1 to 5. From these two questions, it appears that the trainees perceived the training as constructive despite any specific problems with the system.

Question 7 looks at some of the specific problems indicated in the literature review that may cause the system to appear ineffective to the trainees. The numbers of trainees that indicated difficulty with a specific aspect of the system are displayed in Table 3. Although the trainees indicated in other survey questions that the touchscreen was easy to use, five trainees expressed some difficulty with the technology. The most common comment was that the

Table 3. Post-training information survey question 7 results.

TRAINEE DIFFICULTIES

Number of trainees who experienced difficulty with:	TOTAL	PERCENT
Inputting information into the touchscreen monitor	5	28
Understanding audio reports	3	17
Speed or volume of the information presented	0	0
Inputting information into the Integrated Bridge System (IBS)	7	39
Other*	2	11

* Answers to "Other" are explained in the text.

n = 18

trainee was not familiar with touchscreens and it "took some getting used to." Three trainees indicated that they had difficulty understanding audio reports, but the cause was explained as "being involved in something else" or "not paying attention." None of the trainees had difficulty with the speed or volume of information presented. The most common difficulty, as expected from the pre-testing, was inputting information into the Integrated Bridge System (IBS). Seven trainees expressed that they were not familiar with the IBS and this made the

entire training more difficult. Other difficulties expressed included "visualizing what was going on outside the ship" and "dealing with the system warping when I wasn't ready."[14]

Question 8 asks the trainees how effective the student guide was in preparing them for the training. The response to this question was positive with an average score of 3.89 with a standard deviation of 0.58 on a scale of 1 to 5. This is high considering there were numerous suggestions made to allow the trainee more time to study the student guide. One trainee was asked about this contradiction and commented that the guide was good, but more time was needed to digest the information. Although more time may be needed with the student guide prior to using the system, the student guide appears to be an appropriate pre-training instrument. Suggestions for improvements to the student guide are discussed later in this chapter.

Questions 9 and 10 rate the trainee's perception of instructor effectiveness and amount of information provided during the scenario. The trainees appeared to be very satisfied with the information provided by the instructor prior to operating the system. Question 9 had an average score of 4.44 with a standard deviation of 0.51 on a scale of 1 to 5. Instructor intervention did not seem to disturb the trainees who indicated in response to question 10 that the instructor provided neither not enough nor too much information with an average score of 3.22 with a standard deviation of 0.55 on a scale of 1 to 5. So, the trainees felt comfortable with the information provided by the instructor prior to and during the scenario.

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[14]The simulation is shortened through the use of "warping," which advances the trainee and ship's position in the mission at an accelerated rate. During this time no actions are taken by the trainee.

Question 11 rates the trainees' feelings of success during the scenario. The expectation was that either the trainees would not feel successful because they did not complete the scenario, or they might feel successful based on what they may have learned. The responses to this question indicate that the trainees did not feel very successful with an average score of 2.44 with a 1.10 standard deviation on a scale of 1 to 5. Individual comments from trainees support the assertion that the data representing perception of success are correlated with completion of the scenario.

Question 12 asked for input on problems encountered while using the TPCT. The following list represents a summary of the trainees' specific problems:

- Warping compounded mistakes and created confusion.
- Trainees could not "ask" the computer for recommendations.
- They were unfamiliar with the touchscreen.
- They were unfamiliar with the IBS.
- The IBS voyage planner stopped operating properly.

The problem with the IBS voyage planner was software related and corrected immediately. The perceived difficulty with the touchscreen resulted in a recommendation for the addition of a "demo button" on the trainer screen to allow practice on the user interface without activating the scenario. The difficulty with the IBS and the perceived need to verbally interface with the system are discussed in further detail later in this chapter. The warp function was determined to be correctable if the trainee is indoctrinated into the procedure for making adjustments while warping. The system will stop warping if the trainee initiates an action, i.e., orders a course or speed change.

Question 13 asked for input on what aspects of the TPCT the trainees liked the most. The following list represents a summary of the trainees' responses:

- Realism
- Great graphics
- Detail
- Audio reports
- Time pressure
- Touchscreen

Ten trainees responded that they really liked the realism of the system. The graphics, detail, and audio are integral to the high fidelity system and essential to the perception of reality. The pressure of time management was liked by the trainees even though this was determined by the "TLX" to be a stressor. The trainees indicated that the time pressure was a realistic aspect of ship board operations.

Question 14 asked for input on what aspects of the TPCT the trainees liked the least. The following list represents a summary of the trainees' responses:

- Blank video screen, lack of video at times
- Dead time
- Glare on the trainer monitor
- Not being able to ask watchstanders questions
- Uncontrollable warping

The most common dislike was the absence of video when not receiving reports from the system. The trainees indicated that this detracted from the reality and recommended a

continuos video stream. Additionally, the trainees indicated that video could be used to provide visual cues to aid in the decision making process, i.e., video of a fog bank may influence the decision to slow the ship or not. The trainees did not like the "dead time" between events. This appeared to cause anticipation stress, and it was not determined if this stress was beneficial or a hindrance to the goal of the system. The glare on the trainer monitor was noted by several trainees, and it was recommended that the trainer monitor be changed to an etched finished monitor similar to the IBS monitor. The verbal interaction with watchstanders is discussed later in this chapter.

Question 15 asked for specific recommendations for future use of the TPCT. The following list represents a summary of the trainees' recommendations:

- Training for all PC-bound officers
- Ship handling scenarios, i.e., anchoring evolutions, refueling, and man overboard
- More mission-related scenarios
- Casualty control scenarios
- Watch team training and training for other watch stations

Question 16 asked for specific recommendations for future use of the simulation technology used in the TPCT. The following list represents a summary of the trainees' recommendations:

- Engineering Casualty Control (ECC) drills
- Damage control training
- Similar training for different ship types

The post-training information survey data indicate that the TPCT is easy to use, liked

by the trainees, and realistic. But, the survey also indicated some improvement areas and resulted in several recommendations. The survey is further supported by information gained through observation and trainees' comments.

E. OBSERVATIONS AND ADDITIONAL TRAINEE COMMENTS

During each training session the trainees were observed and notes were taken on their comments and questions, physical actions of the trainee, interactions between the trainee and the instructor, and responses by the instructor to the trainee's questions. This section describes those observations as they apply to the research questions and compare to other data instruments.

The "TLX" data show that the TPCT induces stress as intended. Observation of the trainees also indicated that stress was created by the system. The trainees would fidget, wring their hands, and hesitate to make some decisions. Although the trainees would not admit to being stressed, they did indicate that they felt "pressure" to make the right decisions and maintain the time line. They also indicated pressure as a result of the fast pace as well as unfamiliarity with various components.

At the start of each training session, the touchscreen monitor appeared to create stress in the trainees. But the trainees were observed becoming more comfortable with the technology by the start of the second scenario run. Most trainees even seemed to enjoy the use of the touchscreen. This observation combined with the data from the post-training survey supports a recommendation made by the trainees to alter the system to allow practice on the touchscreen to build familiarity. Recommendations were also made to investigate voice recognition as an alternate means of interfacing with the system.

The trainees were observed "talking" to the system. Most often, the trainees would say "no" out loud to deny a recommended action. If the system recommended a course change and the trainee did not agree, then no action on the part of the trainee was required to deny the request, but the trainees expressed a need to actually do something either verbally or physically to indicate a "no" response.

The trainees were also observed to constantly ask for information from the instructor to assist them in the decision making process. As an example, one trainee asked if the ship had departed enemy waters yet. This is information that the trainee should be able to find or would have known if attention was paid to audio reports. If the instructor answered these questions, the scenario would become too easy. The instructor for this evaluation usually responded to these questions with "I can not give you that information." After discussing this with the instructor, it was decided that to simulate reality maybe the instructor could answer as a crew member might with something along the lines of "I'll get back to you on that, sir." The instructor recommended clarifying this in the instructor's guide. But, it should be noted that the data show that the trainees were happy with the information provided.

The instructor's guide also did not include specific information on conducting the pre-training brief. Although the instructor for this evaluation conducted excellent briefs and the trainees were satisfied with the information presented, discussions with the instructor resulted in a recommendation that the brief be standardized and included in the instructor's guide.

The pre-training brief for this evaluation included an extensive review of the IBS that could almost be considered training in itself. The IBS is a complicated navigation and control system that requires some detailed instruction and practice to master. Even with this brief,

the trainees experienced problems operating the IBS mostly because they were unfamiliar with the system. The trainees recommended being taught the IBS before using the TPCT.

The trainees noted the following items that detracted from the reality of the system. At one point in the scenario the fuel percentage indicated 2 percent fuel remaining. It was noted by the trainees that the PC class ship will lose fuel suction and fail to operate if the percentage drops below 10 percent, so 2 percent and still operating is not realistic. In the event of loss of steering gear, the PC class ship has the capability of "steering with engines" while this is not an option in the TPCT. The TPCT has static gauges that do not change in the case of an engine casualty. It was recommended by trainees that the gauges be programmed to indicate actual casualty conditions. Reality was also questioned when it was observed that the successful completion of a decision point only required a minimal decrease in speed instead of a decrease in speed according to standard ship board procedure.

The trainees kept asking for a device known as a "whiz wheel." The small plastic hand-held device is used on ships to calculate time-distance problems. Although the time-distance problems can be calculated by hand, it was recommended that a "whiz wheel" be made available for the trainees to use. Additionally, the trainees did not easily understand how to utilize the IBS system in conjunction with the clock to ensure they were on schedule.

The trainees appeared somewhat agitated that they could not finish the scenario in the 3-hour time frame. The instructor and trainees recommended that the scenario include an alternate starting point to reduce the time involved in starting over. But it was also noted that the trainees expressed a desire to return and try the system again, especially if more and varied scenarios were added.

The observation of training resulted in qualitative support for earlier findings that the TPCT induces stress as intended, the trainees like the system, it is relatively easy to use, and trainees perceive the training as beneficial. This phase of the evaluation also resulted in recommendations for improvements to the system. The following chapter summarizes the findings and presents recommendations based on the data.

VI. CONCLUSIONS AND RECOMMENDATIONS

The purpose of this chapter is to present the results of the formative evaluation of the Tactical Patrol Craft Trainer (TPCT) with regard to the research questions presented in the introduction. The literature review indicated that formative evaluation is important to the development of a successful training system, and prior research provided insight on specific evaluation tools to use and an indication of expected results. The methodology used in this research was directed at answering specific research question, the results of which are presented in the following sections.

A. RESEARCH QUESTIONS

This research was based on the four questions presented in chapter 1 of this thesis. The last two questions in the introduction were eliminated from this study for reasons discussed in the methodology chapter and are not discussed here. The first question contained five parts that asked about specific system changes that were needed for the trainer.

1. What Changes Need to Be Made in the Instructor's Guide?

The instructor's guide provides a clear and concise description of the TPCT system, but it needs to include some specific direction for the instructor. The guide needs to include a section that details a standard pre-training brief to ensure continuity among instructors and among trainees. Included in this brief, the instructor should provide the trainee with instruction on using the Integrated Bridge System (IBS) in conjunction with the trainer clock to solve time management problems. The brief should also contain clarification on responding to a trainee's request for information during the scenario.

2. What Changes Need to Be Made in the Student's Guide?

The Student's Guide was found to be adequate if the trainee is provided with sufficient time to study it. It is recommended that the student be provided with instruction in the guide on using the trainer clock with the IBS to solve time management problems.

3. What Software Problems Need to Be Corrected?

The software operates as designed and the one noted programming problem was corrected. However, various recommendations that involve software changes are listed as follows:

- Add an alternate starting point. This change would allow the trainee to begin a second or third session closer to where there was a missed decision point, reducing the training time, making it possible to complete the scenario, and aiding the perception of success.

- Add a "Permission Denied" button. Although this button would not affect the scenario, it would give the trainees the desired physical action to deny a request from the system instead of simply doing nothing.

- Add a "demo button" to allow familiarity with the user interface.

- Add steering with engines capability. This added feature will add another element of realism, allowing the trainee to take an action that is available on the PC class ship.

- Adjust fuel to indicate a minimum of 10 percent because the current setting of 2 percent is not realistic.

- Change required reduction in speed during fog. The speed reduction required by the trainee should be in accordance with standard operating procedures instead of an arbitrary amount.

- Add temperature changes during engine casualties.

- Add continuous video feed and visual cues.

- Add additional scenarios.

4. What Hardware Problems Need to Be Corrected?

There were no major problems noted with the TPCT hardware. However the recommendation is made to change the trainer monitor to a monitor with an etched finish to reduce glare. Additionally, the hardware needs to be located in a dedicated training area that is free from distractions.

5. What Additional Instruction Needs to Be Conducted Prior to Using the Trainer?

The TPCT trainer relies heavily on the use of the IBS, a complicated system with which the trainees do not have familiarity. It is recommended that a prerequisite to TPCT training course of instruction be developed that teaches the IBS. The IBS component of the TPCT can be used to conduct this training. This training would also provide the trainee with valuable experience on a system that will be on that trainees ship. Other additional instruction items needed were noted in recommended improvements to the Instructor's and Student's guides.

6. What Initial Indications of System Effectiveness are Produced During Beta Testing?

No absolute measures of effectiveness were produced by this research. The research, through the use of survey instruments and trainee perceptions, generated the following indications that the TPCT operated as expected or was perceived as effective.

- The TPCT induces high mental demand.
- The system appears to generate the intended stress levels in trainees.
- The human-system interface is adequate and appropriate.
- The system is relatively easy to use.

- Trainees liked the system.
- Trainees felt the system was realistic.
- Trainees perceived the training as effective.
- Trainees perceived the system as useful.

B. ADDITIONAL FINDINGS AND RECOMMENDATIONS

This research resulted in additional findings and recommendations that were not specific to the original research questions. The following list summarizes these findings and recommendations:

- Perceived performance and success in the training do not appear to affect perceptions of training utility. Although the trainees did not consider themselves successful in the scenario, they still rated the TPCT as a useful training device.
- Most prior experience with computer-based training was positive.
- It is recommended that the system be adapted to train other watchstanders because other watchstanders can encounter the same decision making problems that the TPCT is designed to enhance.
- It is recommend that the TPCT system be used for team training, especially bridge watchteams that are involved in assisting the CO in decision making.
- It is recommend that the technology be used to develop trainers for Engineering Casualty Control (ECC), ship handling, and other ship types.
- It is recommended that the use of voice recognition be investigated as an alternative user interface.

C. RECOMMENDATION STATUS

During the evaluation of the TPCT, recommendations were submitted to Commander Naval Special Warfare Command (COMNAVSPECWARCOM) for review. The following recommendations were approved for implementation:

- Add an alternate starting point.
- Add a “Permission Denied” button.
- Add a “demo button” to allow familiarity with the user interface.
- Add steering with engines capability.
- Adjust fuel to indicate a minimum of 10 percent.
- Change required reduction in speed during fog.
- Add temperature changes during engine casualties.

D. RECOMMENDATIONS FOR FURTHER RESEARCH

Two aspects of further research must be considered. First, any changes to the system, especially software additions, need to undergo continued formative evaluation to ensure the system works properly. Formative evaluation similar to that conducted in this thesis is also recommended for new scenarios or applications of this technology to other areas or ship types. It is also recommended that further research be conducted on the TPCT after implementation to determine training effectiveness.

This research produced initial indicators of effectiveness. Summative evaluation of the TPCT system needs to be conducted to check actual effectiveness. Outcome-based measures of effectiveness need to be developed and tested on trainees that complete a course of instruction on the TPCT. Additionally, trainees can be surveyed at a later time to gain information on perceived utility of the system.

APPENDIX A. TRAINEE DEMOGRAPHIC SURVEY

Mark all that apply (if you had two jobs as a division officer, mark them both).

Last Name:______________________

First Name:______________________

SSN:__________________________

Age:__________________________

Rank:__________________________

YG:___________________________

Education Background
- BS engineering ❑
- BS non-engineering ❑
- BA degree ❑
- MS engineering ❑
- MS non-engineering ❑
- MA degree ❑
- PHD ❑
- Other:________________ ❑
  (specify)

Commissioning Source
- USNA ❑
- NROTC ❑
- OCS ❑
- ECP ❑
- Seaman to Admiral ❑
- Other:________________ ❑
  (specify)

Ship Types Served in
- CRUDES ❑
- AMPHIB ❑
- CV ❑
- Auxiliary ❑
- PC ❑
- MCM/MHC ❑
- Other: ❑
  (specify____________)

Assignment history
- Command at sea ❑
- XO ❑

Department Head
- OPS ❑
- Deck ❑
- Air ❑
- Eng ❑
- CSO ❑
- Weps ❑
- Other:________________ ❑
  (specify)

Division Officer
- Eng ❑
- Deck ❑
- Air ❑
- Ops ❑
- Weps ❑
- CS ❑
- Other:________________ ❑
  (specify)

APPENDIX B. PRE-TRAINING INFORMATION SURVEY

1. Have you ever used an interactive training simulator?

Yes ❑ No ❑

2. Only answer the following if #1 was "Yes".

A. Rate your experience:

Negative Positive
1-------------------2-------------------3-------------------4-------------------5

B. Was the training:

Ineffective Effective
1-------------------2-------------------3-------------------4-------------------5

C. From your experience, could you see future uses for that type of training in the Navy?

Yes ❑ No ❑

APPENDIX C. POST TRAINING ORAL QUESTIONS

Ask the following questions immediately after completion of the last scenario run for the student:
Record answers in the space below.

1. Did you feel pressured to complete a specific task during the mission?

2. Where were you the most pressured?

3. Was there anything you needed to know prior to starting that was not in the Student Guide or explained by the instructor? (What?)

4. Do you feel as if you have learned anything new?(What?)

5. What other benefits did you experience from using the TPCT?

Administer the Post-test surveys (Sources-of-Workload Evaluation, User Interface Dimensions, and the TPCT Post-Training Information survey) , then ask questions 6 thru 9.

6. Did any aspect of the trainer cause you to feel stressed?

7. What aspect caused you to feel stressed?

8. Do you consider this stress a positive or a negative aspect of the trainer?

9. Is there anything you would like to add, recommendations or comments?

APPENDIX D. NASA TASK LOAD INDEX

The evaluation you are about to perform is a technique that has been developed by NASA to assess the relative importance of six factors in determining how much workload you experienced. The procedure is simple: Read the following task descriptions and then mark the scale at the point that reflects the task load that you experienced after completing the trainer. If you have any questions, please ask them now. Thank you for you participation.

1. MENTAL DEMAND

A. How much mental and perceptual activity was required (e.g., thinking, deciding, calculating, remembering, looking searching, etc.)?

Low **High**
0 1 2 3 4 5 6 7 8 9 **10**

B. Was the task easy or demanding, simple or complex, forgiving or exacting?

Low **High**
0 1 2 3 4 5 6 7 8 9 **10**

2. PHYSICAL DEMAND

A. How much physical activity was required (e.g., pushing, pulling, turning, controlling, activating, etc.)?

Low **High**
0 1 2 3 4 5 6 7 8 9 **10**

B. Was the task easy or demanding, slow or brisk, slack or strenuous, restful or laborious?

Low **High**
0 1 2 3 4 5 6 7 8 9 **10**

3. TEMPORAL DEMAND

A. How much time pressure did you feel due to the rate or pace at which the tasks or task elements occurred?

Low **High**
0 1 2 3 4 5 6 7 8 9 **10**

B. Was the pace slow and leisurely or rapid and frantic?

Low **High**
0 1 2 3 4 5 6 7 8 9 **10**

4. PERFORMANCE DEMAND

A. How successful do you think you were in accomplishing the goals of the task set by the experimenter (or yourself)?

Low **High**
0 1 2 3 4 5 6 7 8 9 **10**

B. How satisfied were you with your performance in accomplishing these goals?

Low **High**
0 1 2 3 4 5 6 7 8 9 **10**

5. EFFORT DEMAND

A. How hard did you have to work mentally to accomplish your level of performance?

Low **High**
0 1 2 3 4 5 6 7 8 9 **10**

B. How hard did you have to work physically to accomplish your level of performance?

Low **High**
0 1 2 3 4 5 6 7 8 9 **10**

6. FRUSTRATION

A. How insecure, discouraged, irritated, stressed and annoyed versus secure, gratified, content, relaxed and complacent did you feel during the task?

Low **High**
0 1 2 3 4 5 6 7 8 9 **10**

APPENDIX E. USER INTERFACE DIMENSIONS

Directions: A number of statements that describe the Interactive-multimedia Courseware (ICW) are given below. Read each statement and then circle the number that reflects your opinion. There are no right or wrong answers.

Dimension I - Ease of Use
(Perceived facility with which user interacts with the ICW)

Difficult **Easy**
0 1 2 3 4 5 6 7 8 9 **10**

Dimension 2 - Navigation
(Pperceived ability to move through the contents of the ICW)

Difficult **Easy**
0 1 2 3 4 5 6 7 8 9 **10**

Dimension 3 - Cognitive Load
(Perceived degree that the user interface seems manageable)

Unmanageable **Manageable**
0 1 2 3 4 5 6 7 8 9 **10**

Dimension 4 - Mapping
(Program's ability to track and graphically represent user's path through the program)

None **Powerful**
0 1 2 3 4 5 6 7 8 9 **10**

Dimension 5 - Knowledge Space Compatibility
(Concepts and relationships were compatible with the user's knowledge about the topic)

Incompatible **Compatible**
0 1 2 3 4 5 6 7 8 9 **10**

Dimension 6 - Information Presentation
(Perceived degree that the information contained in the ICW is presented in an understandable form)

Obtuse **Clear**
0 1 2 3 4 5 6 7 8 9 **10**

Dimension 7 - Media Integration
(How much does the ICW coordinate the different media to produce an effective whole)

Uncoordinated **Coordinated**
0 1 2 3 4 5 6 7 8 9 **10**

Dimension 8 - Overall Functionality
(Perceived utility of the ICW in relation to the program's intended use)

Dysfunctional **Highly Functional**
0 1 2 3 4 5 6 7 8 9 **10**

APPENDIX F. POST-TRAINING INFORMATION SURVEY

1. Rate how difficult or easy the TPCT system was to operate.

Difficult Easy
1------------------2------------------3------------------4------------------5

2. Rate how difficult or easy the touch screen was to operate.

Difficult Easy
1------------------2------------------3------------------4------------------5

3. Rate the TPCT Scenario according to the following criteria (note: This question refers to the battle problem itself and not the TPCT system).

Easy Difficult
1------------------2------------------3------------------4------------------5

Confusing Understandable
1------------------2------------------3------------------4------------------5

Slow Fast
1------------------2------------------3------------------4------------------5

Unrealistic Realistic
1------------------2------------------3------------------4------------------5

4. Rate the environment according to the following criteria.

Too Cold Too Hot
1------------------2------------------3------------------4------------------5

Very Uncomfortable Very Comfortable
1------------------2------------------3------------------4------------------5

Too Quiet Too Loud
1------------------2------------------3------------------4------------------5

5. Rate the usefulness of the TPCT as a trainer for prospective PC class Commanding Officers.

Completely Worthless — Very Useful

1-----------------2-----------------3-----------------4-----------------5

6. Rate the usefulness of this type of simulation for other decision making training

Completely Worthless — Very Useful

1-----------------2-----------------3-----------------4-----------------5

7. Mark any area that caused you difficulty while using the TPCT.

- ❑ Inputting information with the touch screen monitor
- ❑ Understanding audio reports
- ❑ Speed or volume of the information presented (did you easily lose track of the situation due to the speed or volume of the information flow?)
- ❑ Inputting information into the Integrated Bridge System (IBS)
- ❑ Other (please specify):

A. In the space provided below, explain why the items you checked caused you difficulty.

8. Rate the effectiveness of the Student Guide (Did it prepare you for operation of the TPCT?)

Ineffective — Effective

1-----------------2-----------------3-----------------4-----------------5

9. Rate the effectiveness of the instructor in providing needed information prior to operation of the TPCT system.

Ineffective — Effective

1-----------------2-----------------3-----------------4-----------------5

10. Did the instructor provide too much or not enough information during the scenario?

Not Enough Too Much
1------------------2------------------3------------------4------------------5

11. How successful do you feel you were during the training scenario?

Not Successful Very Successful
1------------------2------------------3------------------4------------------5

12. What problems did you encounter while using the TPCT?

13. What aspects of the TPCT did you like the most?

14. What aspects of the TPCT did you like the least?

!5. What recommendations would you make for future use of the TPCT?

16. What recommendations would you make for future use of similar trainers?

APPENDIX G. FACILITATOR'S GUIDELINES

Directions for conduct of training for data gathering purposes. The following is a guideline that will assist the facilitator in completing all necessary information for research purposes.

1. Have student read Student Guide, provide 15-30 minutes if needed, note the amount of time the student actually reads the guide and record any questions asked.

2. Brief student on system IAW instructor's guide and include the following:

> "During this training period you will be assisting in the beta test process of the TPCT. Your cooperation in completing pre and post training surveys will be greatly appreciated. The information gathered in the surveys is for research purposes only, to assist in the installation of the TPCT. In no way will your inputs be utilized for other than research. Your candid comments are welcomed and encouraged. Your performance is being examined for the purpose of evaluating the TPCT system."
>
> Have student fill out demographic survey.
>
> Record any questions asked by the student during the brief.

3. Start mission.

> Record questions, statements, and significant actions (i.e., Student looks confused, student yells "NO" to OOD, student says "What do I do now?", even if no answer is given).
>
> Record any assistance given to the student.

4. At end of mission: Debrief the mission, explaining missed training points, answer student questions, and record these items.

5. Run mission again until success or time expiration, continue to evaluate the training using numbers 3 and 4 above until completion.

6. Administer post-training interview and surveys after the final debrief.

7. Collect all surveys, notes and mission evaluation sheets into one package for each student.

8. For the facilitator: note any problems encountered in administering these data sheets:

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